

Feb 2018
Issue 451

YOUR EXPERT

GUIDE TO TODAY'S TECH

**RESURRECT
AN OLD
ANDROID
DEVICE**

HOW TO INSTALL
LINEAGE OS TO GET
THE LATEST
FEATURES &
SECURITY FIXES

**VPNs EXPERT
TESTED &
COMPARED**

WE FIND THE BEST OPTIONS
FOR AUSSIES FOR TOTAL
ACCESS & SECURITY

**GEO-BLOCK
BUSTERS!**

AUSSIE VPN MEGAGUIDE

GET UNRESTRICTED ACCESS IN OUR COMPLETE GUIDE TO DODGING
GEO-BLOCKS AND BREAKING THROUGH ONLINE BARRIERS

UTURE

AUS\$9.95 INC GST
NZ\$10.90 INC GST
PRINT POST
APPROVED: 100000179
ISSN: 0728-4415



UPGRADE YOUR TECH SKILLS

- TWEAK WINDOWS TO MAKE IT BOOT FASTER
- HOW TO OVERCLOCK LOCKED INTEL CPUs
- BUILD A STYLISH BLACK & WHITE WORKHORSE PC
- TROUBLESHOOT WI-FI WITH A RASPBERRY PI

THE FUTURE OF THE PC REVEALED!

WHERE DO WE GO FROM HERE? WE DUST OFF THE CRYSTAL BALL TO DISCOVER THE NEXT PHASE OF THE PERSONAL COMPUTER!

LATEST TECH & PCs LABS TESTED

- INTEL 8TH-GEN CORE I3: FINALLY, 4 CORES ON A BUDGET
- ALIENWARE GAMING DESKTOP: GARGANTUAN SIZE & SPEED
- THE PERFECT GAMING LAPTOP FOR FIRST-PERSON SHOOTERS?
- BENQ'S QUITE AFFORDABLE 32in 4K MONITOR



Vigor2862 Series

DrayTek
Aust & NZ

www.draytek.com.au

**NBN SMB Solution for VDSL2 & Ethernet WAN
(FTTN/B, FTTP, HFC, Fixed Wireless, Statellite)**

VDSL2/ADSL2+ Multi-WAN Gigabit router with dual USB ports for 3G/4G connectivity, VoIP and IEEE 802.11ac Wi-Fi achieving speeds up to 1.7Gbps throughput



Internet

Vigor2862Vac

LAN



VigorSwitch

XYZ Office Building



LAN4: 192.168.8.x

LAN3: 192.168.7.x

LAN2: 192.168.6.x

LAN1: 192.168.5.x

VLAN Features

- Supports up to 8 LAN IP subnets
- Supports up to 16 VLANs, ie up to 16 logical workgroups
- Additional security and traffic management
- IEEE 802.1q allows multiple VLANs to be connected on a simple LAN connection
- Applications examples:
Separation of networks for tenants
Staff in different locations can be grouped as same section

LAN >> VLAN Configuration

VLAN Configuration

LAN						VLAN Tag		
						Enable	VID	Priority
VLAN0	☐	☐	☐	☐	LAN4 ▼	☐	0	0 ▼
VLAN1	☒	☐	☐	☐	LAN1 ▼	☒	10	4 ▼
VLAN2	☐	☒	☐	☐	LAN2 ▼	☒	20	1 ▼
VLAN3	☐	☐	☒	☐	LAN3 ▼	☒	30	2 ▼
VLAN4	☒	☒	☒	☒	LAN4 ▼	☒	40	3 ▼

- VDSL2/ADSL2+, Gigabit Ethernet WAN port, Dual USB ports for failover and load-balancing
- Two USB 2.0 ports for connection to two 3.5G/4G LTE USB mobiles, FTP server and network printer
- 4 x Gigabit LAN ports with multiple subnets and 60,000 NAT sessions
- Integrated IEEE 802.11ac (AC2000) wireless Access Point; dual band; up to 1.7Gbps throughput (ac & Vac model)
- IPv6 & IPv4. Increased IP addresses (1022) and IP subnets (8)
- VoIP (2 x FXS and 1 x FXO Line Port) for Vigor2862Vac
- Object-based SPI Firewall and CSM (Content Security Management) for network security
- High Availability mode
- 16 x VLANs for secure and efficient workgroup management
- 32 x VPN tunnels (including 16 x SSL VPN tunnels)
- Fast VPN throughput, VPN load-balancing and backup for site-to-site applications
- Embedded Central VPN Management for 8 remote Vigor routers
- Central AP Management for deployment of multiple wireless VigorAPs
- Works with Smart Monitor Network Traffic Analyzer
- Works with VigorACS 2 Central Management for multi-site deployment



i-LAN Technology Pty Ltd trading as DrayTek Aust & NZ

www.i-lan.com.au

(02) 9838 8899

sales@i-lan.com.au

© Copyright 2018 i-LAN Technology Pty Ltd. All rights reserved.

apc

Future Publishing Australia, PO Box 1077 Mount Street,
North Sydney, NSW 2059
Tel: 02 9955 2677 Fax: 02 9955 2688
Email: techlife@futurenet.com
Web: www.techlife.net
subscription enquiries: Please call Magshop 13 61 16

Editorial

Editor-in-chief Dan Gardiner
Chief Sub-editor/Journalist Carmel Sealey
Senior Journalist: Shaun Prescott
Senior Journalist: Paul Taylor
Journalist: Joel Burgess
Journalist: Stephen Lambrechts
Journalist: Sharmishta Sarkar
Journalist: Harry Domanski
Creative Director: Troy Coleman
Senior Designer: Nykke Coleman
Designer: Sharnae Swinnerton

Contributors

Jonni Bidwell, JR Bookwalter, Sean Conway, Alex Cox,
David Crookes, Anne-Marie Coyle, Cat Ellis, Ian Evenden,
Fraser Gilbert, Craig Grannell, Phil Iwanik, John Knight,
Kevin Lee, Carrie Marshall, Gary Marshall, Neil Mohr,
Nick Odantzis, Nick Peers, Ian Sleightholm,
Dave Stevenson, Zak Storey, Dominic Tarason,
Nathan Taylor, Alexander Tolstoy, Darren Yates

Photography

All copyrights and trademarks are recognised
and respected

Advertising

Advertising Manager: Paul Marttila
paul.marttila@futurenet.com
Business Development Manager: Stan Geha
stan.geha@futurenet.com

Management

Managing Director Neville Daniels

Printed by Bluestar

Distributed in Australia and NZ by Gordon and Gotch
www.gordongotch.com

ISSN 0728-441

We are committed to only using magazine paper which is derived from
responsibly managed, certified forestry and chlorine-free manufacture. The
paper in this magazine was sourced and produced from sustainable managed
forests, conforming to strict environmental and socioeconomic standards. The
manufacturing paper mill holds full FSC (Forest Stewardship Council) or PEFC
certification and accreditation

All contents © 2018 Future Publishing Australia or published under licence. All
rights reserved. No part of this magazine may be used, stored, transmitted or
reproduced in any way without the prior written permission of the publisher.
Future Publishing Limited (company number 2008885) is registered in England
and Wales. Registered office: Quay House, The Ambury, Bath BA1 1UA. All
information contained in this publication is for information only and is, as far as
we are aware, correct at the time of going to press. Future cannot accept any
responsibility for errors or inaccuracies in such information. You are advised to
contact manufacturers and retailers directly with regard to the price of products/
services referred to in this publication. Apps and websites mentioned in this
publication are not under our control. We are not responsible for their contents or
any other changes or updates to them. This magazine is fully independent and not
affiliated in any way with the companies mentioned herein.

If you submit material to us, you warrant that you own the material and/or have
the necessary rights/permissions to supply the material and you automatically
grant Future and its licensee a licence to publish your submission in whole or
in part in any/all issues and/or editions of publications, in any format published
worldwide and on associated websites, social media channels and associated
products. Any material you submit is sent at your own risk and, although every
care is taken, neither Future nor its employees, agents, subcontractors or licensees
shall be liable for loss or damage. We assume all unsolicited material is for
publication unless otherwise stated, and reserve the right to edit, amend, adapt
all submissions.

Privacy statement

If you provide information about yourself this will be used to provide you with
products or services you have requested. We may supply your information to
contractors to enable us to do this. Future Publishing Australia will also use your
information to inform you of other publications, products, services and events.
Future Publishing Australia may also give your information to organisations that
are providing special prizes or offers and are clearly associated with the Reader Offer.
Unless you tell us not to, Future Publishing Australia may give your information
to other organisations that may use it to inform you of other products, services
or events. If you would like to gain access to the information Future Publishing
Australia holds about you, please contact us.



Future plc is a public
company quoted on the
London Stock Exchange
(symbol: FUTR)
www.futureplc.com

Chief executive Zillah Byng-Thorne
Non-executive chairman Peter Allen
Chief financial officer Penny Ladkin-Brand

Tel +44 (0)1225 442 244



Burning down the barriers

APC's editor reckons you need a VPN. Here's why.



For those who are
puzzled about the
hint of flames/saved-
from-the-fire look to
this month's cover,
rest assured that
there is a link – and
it's all got to do with
this being the 451st

issue of our esteemed 38-year-old
magazine. We couldn't think of a
more serendipitous time to cover
VPNs (and other anti-region-
restriction and censorship
techniques) than in issue 451, with
that number dovetailing nicely with
Ray Bradbury's sci-fi classic on the
same themes, *Fahrenheit 451*.

And a good VPN is pretty much
a must-have in today's computing
climate – and that's as much about
defeating censorship and getting to
geo-blocked content on streaming
services like Netflix as it is about
security and privacy. Since April last
year, it's been mandatory for all
Australian ISPs to keep a metadata
log of much of their users internet
activity and a VPN will obscure
much of that.

It's not in any way illegal to use a
VPN or an encrypted chat service in
Australia either – at least not yet.
Our own Prime Minister's preference
for the Wickr app (www.wickr.com)
is well known, although the general
consensus among the paranoid is
that Signal (signal.org) is the go-to
choice for truly private
communications.

VPNs are great for security, too,
particularly if you're a fan of public
Wi-Fi, which, much like public
swimming pools, do carry some risk
to their users. Free public Wi-Fi is,
in fact, a great way to get yourself
hacked – their open nature and often
lax security mean that they're ripe
for abuse, so if you want to protect
your traffic from being sniffed (and
your logins potentially being stolen),
then encrypting your web traffic via
a VPN is a very sensible precaution.

Geo-blocks are the other big reason
people turn to VPNs, and you may be
surprised to learn that getting access
to other-region streaming content
isn't illegal either (although it may
technically be against the streaming
service's terms of service). In reports
commissioned by the Australian
Government, committees have
repeatedly come down on the side of
consumers in this area, stating that
location-based blocks on digital
content are anti-competitive, as they
restrict choice and don't allow
consumers to shop around and find
the best value.

So if you're not currently using
a VPN, then now is a pretty good time
to start – and this month's
superguide aims to make choosing
and using one as easy as possible.
So what are you waiting for?
Flick to page 42 to find out more! ■

DAN GARDINER

EDITOR-IN-CHIEF

dan.gardiner@futurenet.com

GEO-BLOCK
BUSTERS!

AUSSIE VPN MEGAGUIDE

GET UNRESTRICTED ACCESS IN OUR COMPLETE GUIDE TO DODGING
GEO-BLOCKS AND BREAKING THROUGH ONLINE BARRIERS



18

> HEAD TO HEAD < STOCK COOLING VS AIR TOWERS VS ALL-IN-ONES

WE PIT COMPETING TECHS
IN A HEAD-TO-HEAD
BATTLE TO DECIDE WHICH
ONE IS SUPERIOR

» features

35 INTEL Z370 MOTHERBOARDS

Intel's finally gone beyond four cores with its new mainstream 8th-gen CPUs, but to put 'em to use, you'll need a new motherboard.

42 AUSSIE VPN MEGAGUIDE

The complete Australian guide to breaking through online barriers.

55 COMPUTER & SUPERCOMPUTER: THE FUTURE OF THE PC

Will we still have PCs in the future, and what forms might they take?

61 RESURRECT YOUR OLD ANDROID WITH LINEAGEOS

When Google leaves your smartphone without updates, open source will save the day.

» technotes

8 NEWS

The latest developments in the tech world

10 NUMBER CRUNCH

The numbers behind the big tech news

11 NEWS BRIEF

The benefits of AI

12 GADGETS

Hot tech gear we want to own

14 HOW IT'S DONE

Apple iPhone X

16 EPINIONS

APC's readers are talking about AI and ethics in videogames

17 END USER

Apple's older iPhones do slow down (just don't call it planned obsolescence)

"Is it better than Chrome? Maybe. Is it worth moving from Chrome? No." Android app reviews, page 33



22 ASUS ROG STRIX GL503VS SCAR



20 INTEL CORE I3-8350K



23 ALIENWARE AREA 51



28 LOGITECH G231

» the lab

20 LATEST REVIEWS

- 20 Intel Core i3-8350K
- 21 HP Spectre x2
- 22 ASUS RoG Strix GL503VS Scar
- 23 Alienware Area 51
- 24 ASUS ChromeBook Flip C302
- 26 BenQ PD3200U
- 27 Silicon Power Armor A85
- 28 Creative Sound BlasterX Katana
- 28 Logitech G231
- 29 Bitfenix Enso

30 SOFTWARE REVIEWS

- 30 Windows
- 31 Apple macOS
- 32 iPhone & iPad
- 33 Android
- 34 Linux

» how to

66 QUICK TIPS

We fix readers' computing problems

70 TUTORIALS

- 70 Make Windows boot faster
- 73 Speed up iCloud and Apple updates
- 74 Improve iTunes navigation on Mac
- 76 Make an Apple Watch more secure
- 78 Pro audio on Linux
- 82 Play videos from the Linux terminal
- 85 Secure your Google account
- 88 Harden your Wordpress security

» how to

90 MASTERCLASSES

- 90 Building a black & white workhorse PC
- 94 Troubleshoot your Wi-Fi with a Raspberry Pi
- 98 Play C&C: Red Alert on a Raspberry Pi 3
- 100 Ten next-level Android hacks
- 104 Make your Arduino see colour
- 106 Python's Boolean logic

» downtime

110 GAMES

High-performance playtime

114 CHIP CHAT

Quirky news from the world of geekdom



TURN THE PAGE FOR YOUR EXCLUSIVE FREE SOFTWARE OFFERS

exclusive software

» HOW TO DOWNLOAD YOUR FREE FULL-VERSION PROGRAMS

ISSUE 451, FEBRUARY 2018

Please note that these exclusive APC & TechLife magazine downloads will only be available for a limited time, from **01/02/2018** to **21/03/2018**



RIP, BURN AND ARCHIVE WITH EASE

A completely redesigned update to Ashampoo Burning Studio 2018

FULL VERSION WORTH \$40

Ashampoo Burning Studio 2018 is a safe and versatile burning application. At its cores lies the powerful burning engine that allows users to burn data of any type to all common disc types with a high degree of safety and speed. This includes files, movies, music and backups. High-volume formats such as BD-XL or high-security discs like M-Disc are also supported. Users can furthermore rip audio discs and rename and burn tracks in the process, complete with individual playlists and custom designed covers. Disc spanning helps spread data that exceeds the capacity of a single disc such as huge photo, document or song collections across multiple volumes.

DOWNLOAD LINK: www.ashampoo.com/lpa/apcmagazine



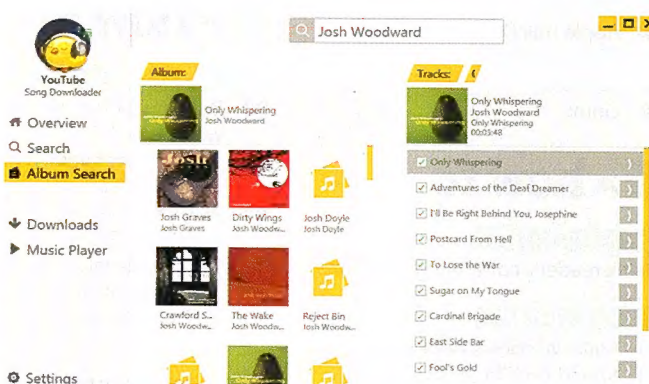
ENJOY YOUTUBE'S SPOILS OFFLINE

Watch and listen later with Abelssoft YouTube Song Downloader

FULL VERSION WORTH \$16.

Undoubtedly, YouTube is the largest video archive in existence. YouTube Song Downloader searches for music videos and downloads them to your hard drive. The newest version offers many important innovations that make the tool even better. These include the ability to extract audio tracks from the videos in up to 320kbs quality MP3s or in the open-source Ogg Vorbis format. Additionally, the software supports the Vevo music service.

DOWNLOAD LINK: www.apcmag.com/exclusives
DOWNLOAD ZIP PASSWORD: February18k



DISCLAIMER Future Publishing is not the licensor of the exclusive software or any documentation included with it. Rather, Future is merely a distributor of the software, and your use of the software is subject to any accompanying third-party licence terms. You must carefully read and comply with any such third-party licence terms, together with all instructions and README files that come with the software. Accordingly, to the maximum extent permitted by law, all software is provided by Future 'as is' and without warranty either express or implied, and Future will not be liable for any damage that you may incur as a result of using any software downloads. You should back up any important system and data files before using any downloaded software. We recommend that you do not use the exclusive software on a production machine. Nothing in this disclaimer excludes any warranty that may be implied by statute, which may include the Trade Practices Act. While we have taken all reasonable steps to check the software downloads for viruses, we cannot guarantee that it is free from viruses or other harmful code and you should check each download using a virus scanner complete with the latest antivirus updates before use.

» INSIDE APC

the latest

» LATEST REVIEWS

DESKTOP CPU
#256 | WWW.NETLIFE.CO.UK

Intel Core i3-8350K

Driving the budget concept in a whole new direction

There are two important factors when it comes to the Intel Core i3-8350K. Firstly, it is unlocked, and secondly, it costs £255. It's good that you can overclock it, but that's unquestionably a lot of money for a chip that most of us would perceive as being a budget offering. For context, this isn't the only 9th-gen Core i3 currently available, as the Core i3-8100 rolls in at a much more palatable £169 – last year's budget king, so sort of price it can expect to compete for budget hardware, even if it has been around for a while.

Pricing aside, it's worth going into what you can do actually get if you, like Intel's new branding, a Core i3 is a core processor that lacks Hyper-Threading (that's a thing), but also lacks a Turbo Boost. To be fair, the base clock frequency of 4.0GHz is healthy enough, even if it won't be able to push more cores

are used. But this CPU also happens to be unlocked, so if you want to push the chip harder, you can. You get 8MB of cache to help get things ticking along nicely, support for up to 64GB of DDR4 RAM, and integrated graphics in the form of Intel's UHD Graphics 630, which has a nominal base clock of 350MHz, capable of hitting a maximum speed of 1.15GHz. While this doesn't quite compete with dedicated graphics silicon when it comes to driving the very latest games, it does mean that you can build a machine without a discrete GPU, keeping both the price and size of the machine down.

There is one small problem when it comes to that notion of budget. It's not that you can't get your options on the motherboard line (it's a single chip), and that's the exact last case (Z370). There is a surprisingly good spread of options here, but what does the cheapest starting at a \$179, we're

some way off the £100 starting point that formed the basis of many a budget Core i3 build using the 10th-generation processors from the previous generation. More budget-conscious chipsets should be on the way, but for now, the combo of this chip alongside the cheap Z370 board starts out at around £430 in Australia. Gulp. Performance, however, is great. That high base clock speed combined with four real cores makes for some great results. Indeed, in testing, this chip was just a shade off the performance offered by the last-gen, Core i7-6700K. Here, we've compared it to the discontinued chip from AMD, the Ryzen 5 1500X, which is a quad-core chip as well, albeit with Simultaneous Multi-Threading, so it can handle eight threads. It's a close neck fight, but the added threads of the Ryzen helped it to win in some areas. But the raw grunt from Intel's single-core processor is trumping Team Red elsewhere.

TEST	INTEL CORE I3-8350K	AMD RYZEN 5 1500X
3DMARK FIRE STRIKE	8,582	8,582
3DMARK FIRE STRIKE U	7,436	7,436
3DMARK FIRE STRIKE S	12,200	12,200
3DMARK WORLDWIDE	667	667
3DMARK WORLDWIDE U	584	584
3DMARK WORLDWIDE S	440	440
3DMARK TIME SPY	36	36
3DMARK TIME SPY U	28	28
3DMARK TIME SPY S	27	27
3DMARK TIME SPY X	27	27
3DMARK TIME SPY Y	27	27
3DMARK TIME SPY Z	27	27
3DMARK TIME SPY W	27	27
3DMARK TIME SPY V	27	27
3DMARK TIME SPY U	27	27
3DMARK TIME SPY S	27	27
3DMARK TIME SPY R	27	27
3DMARK TIME SPY Q	27	27
3DMARK TIME SPY P	27	27
3DMARK TIME SPY O	27	27
3DMARK TIME SPY N	27	27
3DMARK TIME SPY M	27	27
3DMARK TIME SPY L	27	27
3DMARK TIME SPY K	27	27
3DMARK TIME SPY J	27	27
3DMARK TIME SPY I	27	27
3DMARK TIME SPY H	27	27
3DMARK TIME SPY G	27	27
3DMARK TIME SPY F	27	27
3DMARK TIME SPY E	27	27
3DMARK TIME SPY D	27	27
3DMARK TIME SPY C	27	27
3DMARK TIME SPY B	27	27
3DMARK TIME SPY A	27	27

When it comes to overclocking, we managed to get our silicon running at 4.5GHz, with only a little extra voltage (1.4V), resulting in a Cinebench score of 784 (with a single-thread score of 295). Impressive figures.

The real problem for this unit (the Core i3 is Intel's own Core i3-8400, a chip that costs just £250 more, yet boasts 50% more cores. The Core i5 also has more cache and a better TDP of 65W, so you can't overlook that chip, which is a definite win for the Core i3-8350K. But on balance, we still prefer to have the extra cores. Alan Watts

Verdict

Features *****
Performance *****
Value *****

Excellent, but with some performance and great overclocking

★★★★★

28 | www.gamerscore.com

Creative Sound BlasterX Surround

Verdict **★★★★★**

Logitech G29

Verdict **★★★★★**

Silicon Power Armor A85

Verdict **★★★★★**

BitFenix Enso

Verdict **★★★★★**

Find out all about APC's editorial policies, test practices, how to read the benchmark results and more.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, APC's journalists want to know what's good in tech — no matter what platform it resides on.

Championing technology doesn't mean we're unrelenting yes-men, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

technotes

» NEED TO KNOW

Apple promises better parental controls after iPhone addiction claims

ADDRESSING INVESTOR CONCERNS.

In an open letter to Apple, a couple of investors suggested the tech giant address the issue of smartphone addiction amongst children and teenagers as highlighted by a growing number of studies. In response, the *Wall Street Journal* reported that Apple is planning on adding new software tools that will make the parental controls on its devices "even more robust". Details on the new software have not been divulged, however.

SS

NBN Co takes steps to fix peak time congestion

WHOLESALE PRICE DROP AND INCREASE IN BANDWIDTH ON THE TABLE.

We can (hopefully) agree that the NBN is a vastly superior physical network to the Telstra copper telephone wiring that's been the bedrock of Australian internet for many years. However, because of the way internet bandwidth is bought and sold in Australia, customers on the new speedy line have been suffering from congestion issues at peak times that are arguably worse than those on ADSL 2, even on the fastest speed tiers.

In December, NBN Co introduced new wholesale plans to help alleviate network congestion. This new move entails bundling wholesale access and bandwidth charges to ensure a minimum Mbps speed per user, an increase of 0.5Mbps in the base bandwidth sold to RSPs (Retail Service Provider, the new name for ISPs), a 43% discount on additional 1Mbps bandwidth allocations and a discount on the new bundles that puts them in line with current retail offerings. While these changes aren't expected to take effect until the second quarter of 2018, the company is now discounting its current plans to help ease the transition. JB



"A software upgrade last year (iOS 10.2.1) does indeed detect a battery with degraded performance, and slow things down if power demand is too high."

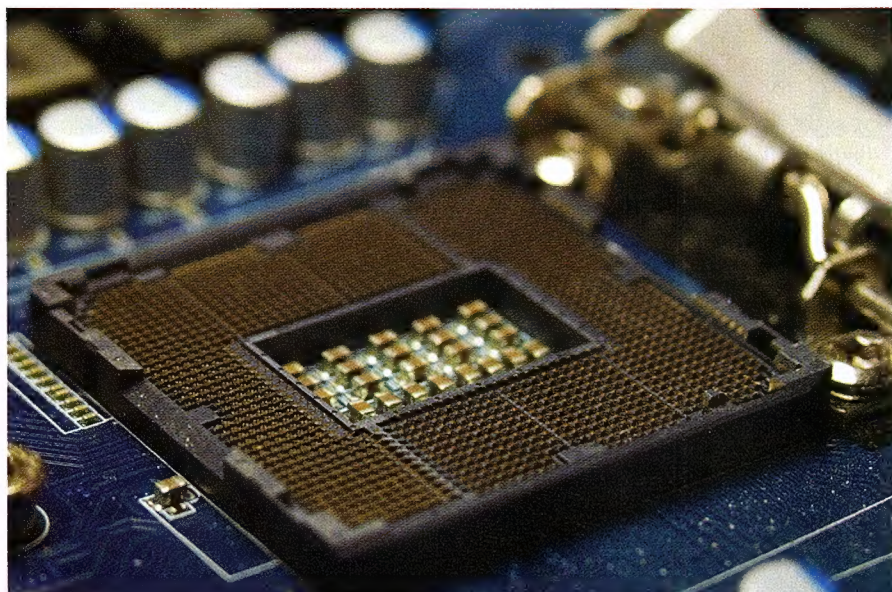
Apple slammed in iPhone battery brouhaha It was for your own good!

Old iPhones can get slow, and the suspicion was always that Apple was deliberately throttling them to push upgrades. The iPhone 6 seemed particularly prone to this. Tempers shortened, forums filled with complaints, and rumours passed back and forth. At least four class action lawsuits were filed. Third-party testing revealed that the slowdown was real: old iPhone's are having their processors slowed down by the OS. Apple finally admitted what it was up to.

Apple issued a statement just before the New Year confirming that a software upgrade last year (iOS 10.2.1) does indeed detect a battery with degraded performance and slow things down if power demand is too high. It did have reasonable technical arguments for this — old batteries can't reliably supply the peak power of a fresh one; if it drops too far below requirements, your phone simply shuts down, which you don't want. That's why iPhone 6 users would see their phone go black at 30-40% charge for no apparent reason. It wasn't being mean, just practical.

In response, Apple has cut the cost of a new battery kit for out-of-warranty iPhones from \$119 to \$39 — a welcome move. This will have your phone running at tip-top speed again. Though you have to wonder why it charged so much in the first place... It also promises to add tools that enable you to get a better picture of your battery's condition. So it's not a diabolical conspiracy to get you to upgrade, just an inept company that won't admit what it's doing until threatened with lawsuits, and a lot of unhappy customers.

One reason this has surfaced is the slowing rate of upgrades — people are hanging on to iPhones for longer than they used to; witness the sluggish sales of the iPhone X. The iPhone 6 has the basic functions you need, and a headphone jack to boot. A surprising number of people are still rocking one, it seems. CL



Huge CPU security flaw discovered, putting millions of devices at risk

OS updates have already been released, but are causing some Windows machines to freeze.

In early January, 20 years' worth of Intel, ARM and AMD CPUs were found to carry a critical flaw, potentially leaving hundreds of millions of computing devices vulnerable to hacking. Software and OS makers were quick to release patches to help mitigate the risk; at the time of print, Intel, AMD and ARM were all working on hardware patches or fixes for their most-recent products, with patches for older devices expected further down the track.

Apple has already partially addressed the flaw in its recent 10.13.2 macOS release, with further tweaks to be added to the upcoming 10.13.3 update. Android phones with the latest security updates should also be safe, said Google, while Microsoft released a patch that would automatically be installed on systems running Windows 10. These patches, it was widely reported, could slow down a computer's performance, but Intel insisted that on its CPUs, the impact was workload-dependent and it should not affect the "average user". A later statement, however, added that there are "cases where the impact may be significant".

At the time of writing, some Windows machines were slowing down or even freezing, because of an incompatibility between the security update and some anti-malware software. That said, Intel CEO Brian Krzanich took the opening moments of his keynote speech at CES 2018 to promise that all machines utilising his company's chips would be patched up by the end of January. **Sharmishta Sarkar**

New WPA3 Wi-Fi security protocol arriving later this year

WI-FI ALLIANCE AIMS TO PATCH CRITICAL FLAW IN FUTURE DEVICES.

Late in 2017, Belgian security researcher Mathy Vanhoef published his discovery of a major flaw in the Wi-Fi Protected Access V2 (WPA2) security protocol that exposed almost every Wi-Fi-enabled device to potential hacking and theft of sensitive information. In response, the Wi-Fi Alliance has announced that Version 3 of the protocol (WPA3) will become available later in 2018, bringing with it defences against brute-force password guessing and the aforementioned flaw, alongside other tweaks. **HD**

US publicly blames North Korea for devastating WannaCry ransomware attack

BASED ON EVIDENCE FROM UK, MICROSOFT AND MORE.

In May 2017, RansomWare known as WannaCry spread across computers in over 150 countries, locking down hospitals and other major businesses. The US (by way of President Trump's Homeland Security Advisor Thomas Bossert) has now publicly declared North Korea as being responsible for the attacks in an op-ed in the *Wall Street Journal*. The claim "is based on evidence" and the findings are apparently supported by the UK, Microsoft, third-party cybersecurity experts and information from the victims themselves. **HD**

Telstra considers high-altitude drones or balloons to distribute broadband

POTENTIALLY REPLACING SATELLITE IN REMOTE REGIONS.

After having previously discussed high-altitude broadband platforms, and even trialling them in 2014 (as part of Google's Loon project), Telstra has expressed renewed interest in the use of balloons or drones to replace satellite technology in distributing broadband within Australia. In particular, the company is looking at the technology for use "during times of natural disaster, but also for longer term provision in regional and remote areas", although the telco says it would need some regulatory flexibility if it were to utilise drones fully. **HD**

Inquiry into how NBN Co sets service standards publicly backed by major RSPs

TELSTRA, OPTUS, TPG AND VOCUS HAVE ALL THROWN DOWN.

In November 2017, the ACCC announced an inquiry into how NBN Co sets its standards for wholesale service after some RSPs showed concern. Since then, Telstra, Optus, TPG and Vocus have all publicly shown their support for the inquiry, a group that makes up 88% of the NBN market, vocalising their worry that the standards will result in customers receiving a lesser service than the RSPs' current legacy connections. **HD**

numbercrunch

» HARRY DOMANSKI LOOKS AT THE NUMBERS DRIVING THE BIG TECH NEWS



NUMBER OF AUSSIES THAT HAVE WATCHED ESPORTS, AND MOST OF THEM WANT TO DO SO AGAIN

According to a report conducted by global research group YouGov, 15% of Australian adults have admitted to watching esports, equating to around 4 million people. What's more, 80% of these people that dipped their toes in the world of competitive-gaming-watching say that they would do so again, and over 2 million Australians watch it at least monthly. Based on the impressive spectatorship in the US and China (which we're currently lagging behind), YouGov is predicting a similar growth in interest in the Australian market.



2030

THE YEAR BY WHICH MICROSOFT HAS PLEDGED TO REDUCE ITS CARBON EMISSIONS BY 75%

The latest carbon emission target set by Microsoft involves a pledge to reduce 75% of operational carbon emissions by 2030, which could ostensibly remove 10 million metric tonnes of carbon emissions in this timeframe. The commitment is in response to US President Donald Trump's decision to pull out of the Paris Climate Agreement, with a Microsoft blog post stating, "it's our hope that this pledge inspires others to join us in setting targets, and provides confidence to governments, companies, and individuals that it's possible."



50%

AMOUNT OF THIRD-PARTY SELLERS ON AMAZON AUSTRALIA THAT ARE SHIPPING FROM CHINA

The recently launched Amazon Australia hosts around 20 million products (at the time of writing) offered by over 2,000 third-party sellers across the Marketplace. It turns out that just over half of these sellers list their shipping location as China. This is a combination of Chinese retailers and Australian sellers that have their warehouses located in China, but as the service gains traction Down Under, it will be interesting to see how this local/international supply balance changes.



\$22 million

AMOUNT THAT THE HIGHEST-EARNING YOUTUBER, DANTDM, EARNED IN THE LAST FINANCIAL YEAR

Since 2015, Forbes has been keeping track of the dollars that YouTube celebrities have raked in, and in the last financial year, 26-year-old Daniel Middleton from the UK (aka DanTDM) topped the charts. Earning \$22 million and racking up over 17 million followers, Middleton's streaming footage of him playing *Minecraft* has led him to tour the world and even sell out four nights at the Sydney Opera House. Second place went to Evan Fong (VanossGaming) who earned around \$20 million from his *GTA V* and *Call of Duty* streaming.



21 years old

AGE OF THE THREE CODERS RESPONSIBLE FOR BRINGING DOWN THE INTERNET WITH DOS ATTACKS IN 2016

In 2016, the Mirai botnet infected hundreds of thousands of connected devices around the world, which, in turn, were used to DDoS several internet infrastructure firms that managed the likes of PayPal, Twitter, and Spotify. Three individuals, all aged 21, have plead guilty to various charges relating to the development and use of Mirai, including writing the code and infecting devices for criminal gain, as the targeted internet firms were rivals to the hackers' own business. ■

tech**brief**

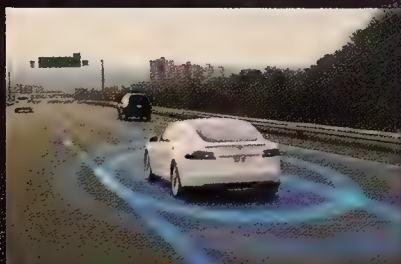
» CARMEL SEALEY WADES INTO A CURRENT NEWS TOPIC TO TAKE A CLOSER LOOK

Our artificially intelligent future

While dark and depressing in movies, AI could actually be a powerful force for good, as well.

Artificial intelligence is very much in its infancy in 2018 – we're nowhere near *Terminator* or *Matrix*-scale levels of intelligence yet, don't worry. At this stage, the pros and cons of AI are still being debated, with notable persons such as Elon Musk and Stephen Hawking voicing caution. But while we are far from the realms of truly self-aware robots, the AI in use today has proven to be invaluable in many professions, with the future looking very bright indeed. Imagine

automated cars ferrying disabled persons from A to B, providing them a level of independence they have not yet experienced. Imagine, too, a doctor using a specialised algorithm to help detect cancer. Then perhaps imagine monitoring stations identifying the climate to help predict severe weather and send early warning signs to infected areas. Perhaps AI will even be able to save endangered animals from extinction. The possibilities, as they say, are endless. Here are just a few things AI can help us do now.



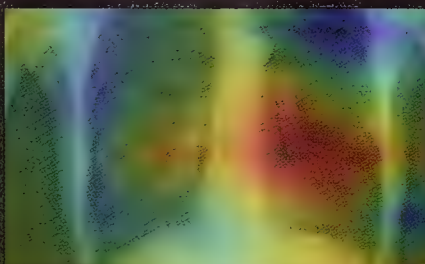
On the road

Most road incidents are due to human error, including being tired, intoxicated, distracted, taking risks or not seeing a hazard. AI has been proven to react faster to danger than humans, and with automated cars possessing cameras in all directions, less will escape notice. The future holds a great big uncertainty, however, with regards to ethics in the event of an inevitable crash.



In the workspace

IBM's Watson has graced the pages of this magazine before. Last year, a special version of Watson was created to identify and prevent cyber attacks. It can apparently spot suspicious activity in a computer system and help thwart them. Not to be outdone, RAVN is an AI platform designed for sifting through documents, then summarising them, identifying key themes and organising them. This could save human workers thousands of hours of time.



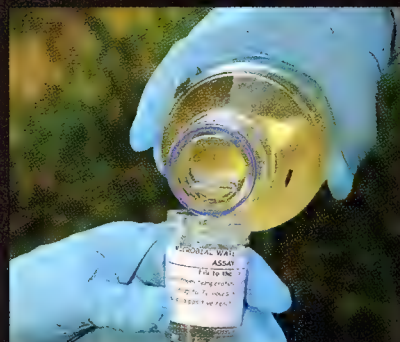
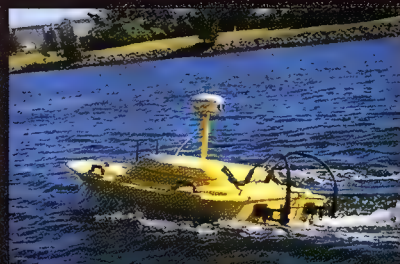
In the labs

Stanford ML Group's pneumonia-detecting algorithm (CheXNet) has now surpassed radiologists' skills, and Zebra Medical has developed a medical image data analysis program. AI's involvement in this field could mean faster diagnoses for patients, but also the identification of trends. Also Microsoft's Project InnerEye can create a 3D map of a patient's organs to help surgeons while in theatre.



In the classroom

Factmata is "a fact-checking community, leveraged by artificial intelligence" — taking a stand against 'alternate facts', misinformation and fake news. We don't need to tell you how important that sort of tool will be in the education of our future generations. For the teachers, AI could help break down results statistics to allow them to better understand their students' needs, as well as free up time so that the teachers can spend one-on-one sessions with the students who need it most.



In the wild

Microsoft is putting its hands in a lot of AI pies, which is definitely a good thing. As well as its InnerEye tech, Microsoft's AI for Earth program was created to provide AI tools to individuals and organisations who wish to use them to preserve the environment. Machine learning and algorithms can help identify species to keep track of population numbers and location diversity. It can also help farmers make better use of the land by monitoring the health of the soil. AI can help monitor fresh water, and also interpret vast quantities of data to make more accurate predictions about climate. While we're only mentioning Microsoft here, the company's Chief Environmental Scientist himself predicts that "every major tech firm" will have similar goals in the years to come. ■

gadgets

» GEAR WE WANT

NINETY7 LOFT

Lift your Google Home speaker into portability.

US\$49.95 | NINETY7LIFE.COM

Google's AI smart speaker can tell you the weather outside, keep track of your hectic schedule and even control your smart home, but one thing it can't do particularly well is move around. Tethered by a power cable, one of the compromises of the Google Home, when compared against portable AI assistant speakers (like, say, JBL's Link 10), is that it's basically got to be sat in the one spot... or at least it did previously. Loft is a portable battery base for the Google Home that swaps out the stock grill for a clean metal frame and a battery disk base that holds 8 hours for charge, so you can bring your Home with you wherever you go. **JB**



LITTLE BITS DROID INVENTOR KIT

Small parts big creations.

\$99.95 | LITTLEBITS.CC



Little Bits has carved out a niche for creating modular Lego-like construction sets for those who like to build the software of robots and remote controlled toys, as well as the usual physical components. Picking up on the trend for novel droids in the new *Star Wars* trilogy, Little Bits is keen to give young millenials the opportunity to create the *Star Wars* droids of the future with a new droid construction kit. The Droid Inventor Kit comes with the standard central construction board, motors and controllers, but it also includes an R2-D2 shell to let any members of The Resistance know that the Force is strong with this one. **JB**

BENQ W1700 4K HDR HOMECINE PROJECTOR

Turn your living room into a true home cinema.

\$2,499 | WWW.BENQ.COM.AU

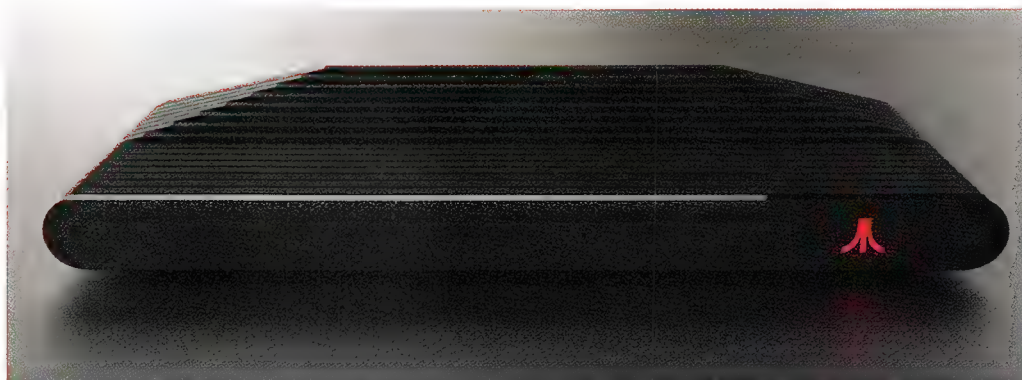
Some APC staffers are happiest whiling away their free time by climbing mountains (cough, Troy). The rest of us feel that it's actually the perfect time a perpetual movie night. You too? Well, then, BenQ's new projector could help you well and truly de-stress from your last week at work in an exhilarating blur of big-screen action, at a low price. The W1700 4K HDR HomeCine Projector comes loaded with an 8.3MP UHD 4K-res picture enhanced by CinematicColor, plus projection-optimised HDR. It's compatible with HDMI dongles for streaming content and there are custom-tuned sound modes. Fancy watching *It* on a 100-inch screen? We don't, but BenQ's 1.2X Zoom tech will kindly oblige all the same.



ATARIBOX

Back to the future of consoles.

\$TBC | ATARIBOX.COM



It's been some time since Atari's heyday, but the creators of the world's first gaming console are hoping to leverage its continuing goodwill in a crowdfunding campaign for a modern revival of the computing relic. While the core components of the Ataribox are designed to placate the nostalgia for the original consoles, the device is also intended to be capable of running new indie games on its

open-source Linux platform. There isn't much information about the custom AMD APU that the console will be fitted with and the intended launch date for the Indiegogo campaign was actually delayed in December 2017 due to a missing 'key element', but this revival seems like it might have enough momentum to get the device up and running at some point in 2018. **JB**

BULTACO ALBERO

Zero emissions, maximum coolness.

£4,265 | BULTACO.COM/EN

If you don't want to drive to the office, but the distance is too far to walk, you're left with public transport or cycling. The latter is better for the planet and your health, and with the continued rise of ebikes, the cycling commute gets easier every year. Especially this year, with Bultaco's new hybrid two-wheeler — it's much more than a bike, yet not purely a motorbike. Either way, the gnarly Albero has coolness and e-prowess. A high-powered, urban-focused ride, this 250-watt engine 'moto-bike' has a top speed of 25kph and a 100km range per (three-hour) charge, with 100% electric propulsion controlled by the throttle. It'll chew up your commute, and make you more badass than any other two-wheel urbanite. The Bultaco Albero makes eco-tech more attractive than ever before.



VI AI TRAINER

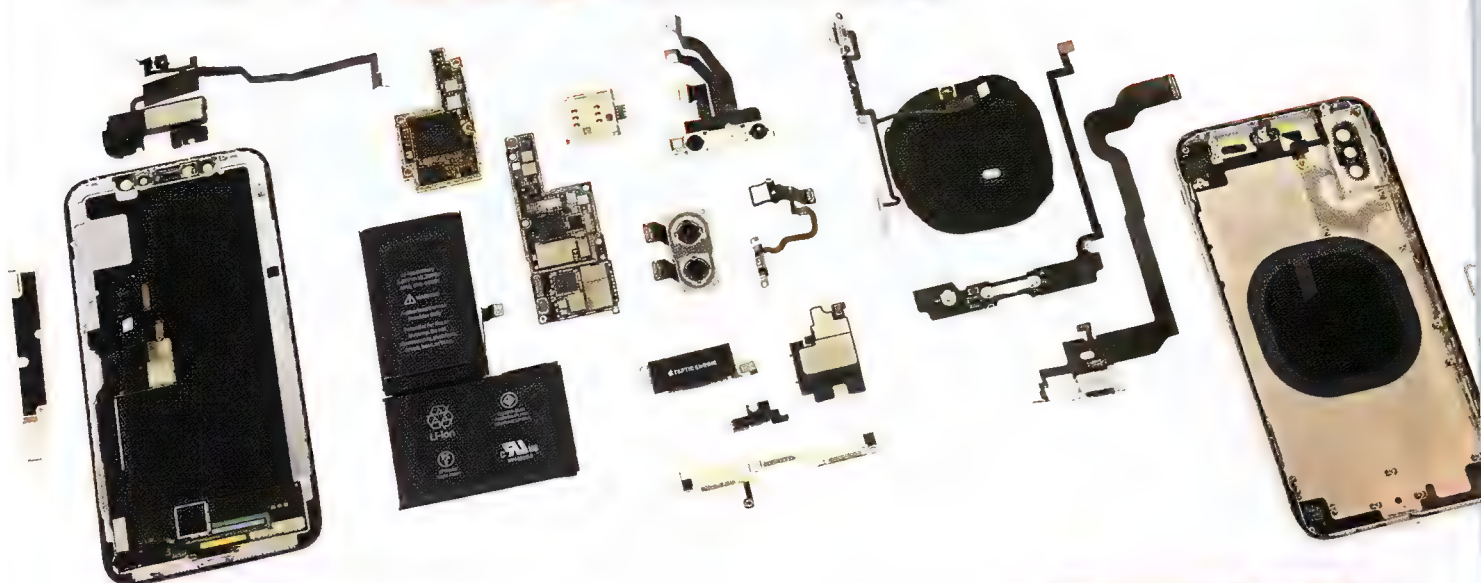
Smash your new fitness goal.

US\$249 | GETVI.COM



We go to the gym. We've had a bash at some deadlifts. Honestly, we need instruction. And encouragement. Lots of encouragement. If you need the input of a personal trainer, and like the idea of something high-tech, we might have the answer: the app-connected Vi AI Trainer. While it looks like a pair of regular sports earphones, inside lives your own PT. She'll spot you during exercise — with the potential for her initial workout knowledge to expand with regular use — give you biofeedback and the encouragement you need to push through those brutal last reps. This AI personal trainer will also help you create workouts, and thrill you with Harman/Kardon-powered sound. Vi reckons the aerospace-grade biosensors are more accurate than any fitness tracker currently on the market. So let's hit the gym and find out... **■**

how it's done



Apple iPhone X

Apple's latest gets put under the microscope.

A little over 10 years ago, Apple introduced the first iPhone. Now we're taking apart the 18th iteration – the iPhone X. With its rounded edges and edge-to-edge display, we're sure this is the iPhone Steve imagined all those years ago – but now that his dream is realised, will it be as influential as the first? Time will tell...

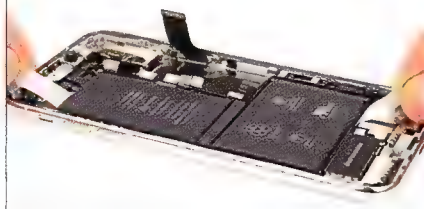
MAJOR TECH SPECS

- A11 'Bionic' chip with neural engine and embedded M11 motion coprocessor
- 5.8-inch OLED multitouch 2,436 x 1,125 (458 ppi) Super Retina HD display
- Dual 12MP cameras (wide-angle and telephoto), with f/1.8 and f/2.4 apertures, and OIS
- 7MP TrueDepth camera with f/2.2 aperture, 1080p HD video recording, and Face ID
- Support for fast-charge and Qi wireless charging
- Our A1865 global unit has broad cellular band support, as well as 802.11a/b/g/n/ac Wi-Fi, MIMO, Bluetooth 5.0 and NFC

KEY FINDINGS

- The iPhone has come a long way in 10 years – so long, that the design has

Once you're properly inside, there's not much to see beyond a whole lot of battery.

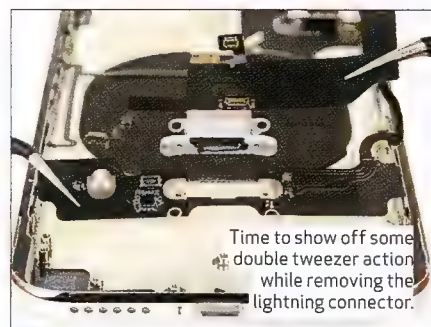


cycled back a bit, and this looks more like the original than we've seen in a long time. As with the iPhone 8, Apple has banished the unsightly (and environmentally responsible) regulatory markings from the back.

- The pentalobe screws at the bottom look weirdly unfinished – the bottom ones are more like pins. Luckily, they haven't rearranged too much else, as our typical trifecta of iOpener, iSlack and iFixit Opening Picks works, as in the past.
- Looks like sideways-opening iPhones are here to stay. Inside, a single bracket covers every logic board connector – we've never seen this kind of connector density. We're faced with tri-point screws standing sentry over any repairs once you get past the pentalobe screws guarding

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit: www.ifixit.com



Time to show off some double tweezer action while removing the lightning connector.

the door. Something tells us Apple doesn't really want us tinkering.

- We finally free this most dense of logic boards to get a closer look – it is incredibly space efficient. Comparing the two boards, the iPhone X motherboard is about 70% of the size of the iPhone 8 Plus board – more space for battery.
- The dual rear camera has a beefy bracket that looks like it might offer some bendgate-proofing support for the delicate components. The cameras are also secured to the rear case with some foam adhesive to keep things from jostling out of place. These cameras really need to stay put for Portrait Mode and similar features to work their magic. Surrounding the camera housing cover glass, you can see tiny spot welds, likely holding the walls of the camera bump to the case.
- **Repairability Score:** 6 out of 10 (10 is easiest to repair). A cracked display can be replaced without removing the biometric Face ID hardware. Liberal use of screws is preferable to glue – but you'll need Apple-specific drivers (Pentalobe and tri-point), in addition to a standard Phillips. Waterproofing complicates some repairs, but makes difficult water damage repairs less likely. Glass on front and back doubles the likelihood of drop damage. ■



The home of technology

techradar.com

epinions

1000 bounty added to Whiterun



THE ETHICS OF KILLING KIDS IN VIDEOGAMES

I know the subject of this email is perhaps a bit racy, but before you reach for the phone to call the police, hear me out. I'm talking specifically about the children in *The Elder Scrolls: Skyrim*. Yeah, that's right, you're with me now, aren't you? The fact that you can kill practically anybody in this game except the ones you most want to get me thinking. What message are they trying to send to gamers – that the murder of children is bad? I think we all know that already. The murder of regular people is also bad, but that is 100% allowed. Age doesn't necessarily indicate innocence in this game – take Aventus Aretino, for example, a mere boy who hires you to kill Grelod the Kind – and let's not forget Babette the child vampire who works for the Dark Brotherhood and specialises in poisons.

So is there a way that games can discourage you from killing certain people without making it impossible? I'm reminded of the 'Altair didn't kill civilians' desynchronising moments from the original *Assassin's Creed*. Kill too many innocent people and you would be forced to reload a previous checkpoint. I liked this mechanic. Wouldn't it be better to create some

sort of system to punish people who went about killing civilians for no reason? Perhaps you're frowned upon by the gods or something and your mana degrades and you have to go on a pilgrimage to try to regain their favour – a bit like what happened back in the *Oblivion* DLC *Knights of the Nine*. I enjoyed the way that *Dishonored* discouraged you from violence by increasing the number of flesh-eating rats that roamed the streets, too.

True, *Skyrim* is a bit old now to start demanding new game mechanics, but I'd like to see a game that does this somewhere down the line. Maybe you could lose 'influence' points if you're trying to become loved by the people, or maybe the ghosts of the guys you killed come back to haunt you and get in your way when you're in a fight, making it hard to see your current enemy? Sigh. I can dream.

Josh Kane

CORTANA IS NOT A CATHOLIC

I was reading an interesting article on *The Financial Review* website the other day (tinyurl.com/apc451-finrev) about virtual assistants and religion. The article asked the question whether virtual assistants, such as Cortana and Siri, should be secular, neutral or

religious in their response to the question: "Should I believe in a god?" As someone who has recently bought an Apple Watch, I've found myself asking Siri a lot of banal questions, such as what the weather will be like, will it rain or what the date will be X weeks from now. But, inevitably, when Siri and her fellows are capable of answering more complex questions, the population will soon turn to virtual assistants for more complicated matters. Who will be in charge of their responses for things like "I feel depressed, who should I talk to?" Will Siri respond "Here is the number for Beyond Blue", "Why not phone a friend?" or will she suggest you go talk to your spiritual leader? Is it up to companies to decide what's best for the users of their virtual assistants? If a powerful church body manages to gain influence over Cortana, for instance, will she suggest we read some Christian Science texts rather a self-help book? Or will the assistant take into account a user's own beliefs and cater to them? What if common sense then needs to take priority over those beliefs? There's just so much that needs to be considered! It's a long, exciting and potentially scary road ahead for AI. I'm glad but also slightly nervous to be alive at this point in history! Sam Collins ■

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

Apple's older iPhones do slow down (just don't call it planned obsolescence)



The company has publicly admitted it slows down its iPhones in certain scenarios but, **Shaun Prescott** asks, is it really necessary?

One of the enduring debates surrounding smartphones — not to mention other modern smart devices — is the question of whether they're designed to work poorly as they age. This is the concept of 'planned obsolescence', a (technically mythical, but in some cases provable) way of killing off older product models in order to force consumers to purchase newer (and usually more expensive) iterations. We've written about it before in this column, and pointed out benchmarks that seem to disprove the practise — at least where Apple was concerned. But that doesn't mean certain aspects of phone won't deteriorate and, often, it's not just a case of normal wear and tear.

Indeed, Apple confirmed in December last year that older iPhones are slowed down, but the company is naturally not calling it 'planned obsolescence'. Instead, it claims that the practice of slowing phones down is to get more mileage out of its batteries. This

so-called feature — which applies to the iPhone 6, 6S, SE and the iPhone 7 if they've had the latest firmware updates installed — will also apply to all future iterations of the iPhone. In a statement provided to *The Guardian*, a spokesperson said: "our goal is to deliver the best experience for customers, which includes overall performance and prolonging the life of their devices." It continued: "Last year we released a feature for iPhone 6, iPhone 6S and iPhone SE to smooth out the instantaneous peaks only when needed to prevent the device from unexpectedly shutting down during these conditions. We've now extended that feature to iPhone 7 with iOS 11.2, and plan to add support for other products in the future."

Of course, Apple didn't pre-empt the inevitable outrage this information prompted: it did so after Reddit users noticed it, and then, after benchmarking company Primate Labs confirmed it. In their report, the company's founder wrote that this new

performance reduction will only confuse consumers. "While this state is created to mask a deficiency in battery power, users may believe that the slowdown is due to CPU performance, instead of battery performance, which is triggering an Apple-introduced CPU slowdown."

In this day and age, users are well-acquainted with the concept of their hardware changing with time, whether it be via operating system revamps or — as was the case with the first Xbox One — newly unlocked processing power. But consumers are generally right in suspecting that companies are poking them into forking out money for newer products.

And there's a case to be made that Apple might not really need to change its OS as frequently as it does, and that with the added resources new features generally require, this practice tends to hamper a phone's performance in a way that neutralises any other new benefits or features introduced. But that's for the consumer to decide, ultimately. ■

END USER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

Head to head: Stock cooling vs air towers vs all-in-ones

Zak Storey attempts to discover which is the best solution to keep your computer cool.

For most people, cooling is an unwanted expense. And, arguably, they're right. If all you're doing is building a rig for office work and browsing the web, the included case fans and stock CPU heatsink are usually sufficient. But when you're using heavier-hitting hardware and putting more demands on your machine, something a little meatier is called for. So, it's time to work out which of the three main types of CPU cooler wins the title of world's best.



Above: Intel's prestigious stock cooler is almost legendary. Right: Noctua's NH-D15 air tower is an absolute beast. Far right: Thanks to a variety of radiator sizes, AIOs are super-easy to fit.

Round 1

COST

When it comes to spec'ing up a new rig, the cost of cooling is a major issue, and it can also be a big part of the overall cost of a processor. Take AMD, for example — all its X edition processors lack a stock cooler as standard. The same goes for Intel's K series. This means that, even if you're not that keen to overclock and push your chip to the max, but are just after the chip's full-fat performance and higher frequencies, you have no choice but to buy some form of aftermarket cooler. As a whole, so far as value for money goes, both AMD and Intel's stock heatsinks are clearly kings of the hill. Adding little extra to the overall price of the processor, these TDP-busting parts are often included with lower-specced CPUs for free. Air towers fall into second place in this battle for bang-for-buck supremacy, with prices ranging all the way from \$20 up to \$150, in some cases, with the top end touting impressive TDP-reducing properties. And lastly, of course, there are AIO liquid coolers. Although you can find a few at fairly reasonable prices, they generally range anywhere from \$80 all the way up to \$200 or more, due to their complex designs and additional components.

WINNER
Stock

Round 2

EASE OF INSTALLATION

Most methods have installation issues. Intel's stock cooler can cause trouble if you're not used to the design of its push pin mounting mechanism, and AMD's latch mounting can lead to a lot of cut fingers and frustration, too. We're going to give a special mention here to AMD's stock Wraith Spire, though, as it's one of the best mounting designs we've seen on a stock fan, relying on four diagonal screws to be secured, and that's it. Air towers vary when it comes to ease of installation, with some manufacturers being less than helpful — usually, the more you pay, the easier it is to install, Noctua models, in particular, are exceptionally painless. Taking the tower clearance of your chassis into account is pivotal, because some air towers can be too big for your system. Ultimately, however, as long as you have the radiator mounting space (and, let's face it, almost every chassis has support for a single 120mm), AIOs win the day. Moving the surface area for cooling to the sides of the chassis, and away from the centre, allows better compatibility with memory. On top of that, most AIOs follow Asetek's patent, meaning an identical mounting solution.

WINNER
All-in-one

Round 3

COOLING EFFICIENCY

All cooling follows the same basic principle: Via the use of convection and vapour for air towers, and a pump and liquid for AIOs, heat is transferred away from the CPU and toward the fins, where it is then cooled by cold air passing across it, before it returns back down to the CPU to start the process again. Regardless of whether that's a stock heatsink, air tower, AIO or even a full loop, each method follows the same idea. So when it comes to efficiency, there's one simple rule to follow: The more surface area you can cool, the better your cooling is going to be. Right now, AIOs rule the roost. With the largest radiators topping out at 360mm in length, and supporting up to six 120mm fans, these are designed for the biggest processors and the beefiest of overclocks. Air towers come a close second, with the likes of Noctua's NH-D15 supporting up to two 140mm fans over two towers. And, lastly, the stock cooler, with its tiny individual sub-120mm fans, falls into third place. Although capable in some cases of supporting overclocks, these coolers are typically only there for — as the name suggests — running at stock.

WINNER
All-in-one

"Although liquid coolers are by far the most efficient at transferring heat quickly, and a fantastic option for those looking for a stylish and compatible cooling solution for the hearts of their machines, there is some inherent risk."



Round 4

NOISE

Despite what many think, more fans doesn't necessarily mean more noise. The theory here is simple: As you inevitably always have the same maximum temperature to alleviate, you always need to hit that as a bare minimum. One fan cooling a processor, for example, would need to be spun at a far higher RPM (generating much more noise) to provide similarly efficient cooling as two fans of the same size over the same surface area. Because of this, and due to the way that decibels scale logarithmically, two 24dB fans (where 25dB is a doubling in noise), operating in tandem, are far quieter than a single 32dB fan. In a similar fashion as cooling efficiency, stock coolers are generally not the best fit for this. Although they can be quiet, due to the type of chip they're likely cooling, the smaller sized fan and lack of surface area mean higher RPMs. We could hand this to AIOs, due to their increased surface area over air towers, but there's one hiccup: the poor quality of the stock fans included. Most air towers are designed with lower RPM, quieter fans in mind, because the cost comes from those rather than the pump and radiator.

WINNER
Air tower

Round 5

RELIABILITY

As systems become ever more integrated into our daily lives and our work, from cryptomining to rendering rigs, office workstations, and even the gaming rig used for relaxing in the evening, reliability is paramount. Both AIO coolers and air towers generally come with fantastic warranties, but there's one big problem when it comes to liquid coolers: If it breaks or, even worse, leaks, it can take your entire system with it. Liquid and PC hardware simply don't mix. On top of that, if your pump stops working in a water block, that CPU is going to cook very quickly indeed, and shut off your system even at idle. Air towers, on the other hand, don't have this moving pump part, and can still operate, thanks to the power of convection, even if a fan breaks. In addition, if your pump dies in an AIO, you have no choice but to replace the entire unit; if a fan dies on an air tower, you simply replace the fan — at a far lower cost. Stock coolers face a similar problem as liquid coolers: If the fan dies, due to the lack of significant surface area, that processor is going to get hot quickly, and you'll have no choice but to replace it.

WINNER
Air tower

And the winner is...

There never will be a one-solution-fits-all when it comes to CPU heatsinks. Regardless of how you look at it, whether it's one of our three categories or something else, each type of cooling has its flaws. Ultimately, it often depends entirely on what processor you're cooling — after all, there's not much point putting a 360mm triple-fan AIO on top of an Intel Core i3-8100. For many, the stock cooler will work just fine. However, for us, arguably it's all about choosing the right aftermarket solution AIO or tower. Although liquid coolers are by far the most efficient at transferring heat quickly, and a fantastic option for those looking for a stylish and compatible cooling solution for the hearts of their machines, there is some inherent risk. If it were a life and death situation, and someone forced us to pick just one, an air tower would be our answer. They simply are king of the hill. OK, so there are a few clearance issues every now and again, but thanks to their simple design, exceptional performance, and consistent reliability, there's little not to love about them. ■



DESKTOP CPU

\$260 | WWW.INTEL.COM

Intel Core i3-8350K

Driving the budget concept in a whole new direction.

There are two important factors when it comes to the Core i3-8350K. Firstly, it is unlocked, and secondly, it costs \$260. It's good that you can overclock it, but that's unquestionably a lot of money for a chip that most of us would perceive as being a budget offering. For context, this isn't the only 8th-gen Core i3 currently available, as the Core i3-8100 rolls in at a much more palatable \$169 – Intel clearly knows what sort of price it can expect to charge for budget hardware, even if it has decided to ignore that here.

Pricing aside, it's worth going over what your cash does actually get you. Under Intel's new branding, a Core i3 is a quad-core processor that lacks Hyper-Threading (just like the Core i5), but also lacks a Turbo mode. To be fair, the base clock frequency of 4GHz is healthy enough, even if it won't be jumping up and down as more/fewer cores

are used. But this CPU also happens to be unlocked, so if you want to push the chip harder, you can.

You get 8MB of cache to help keep things ticking along nicely, support for up to 64GB of DDR4 RAM, and integrated graphics in the form of Intel's UHD Graphics 630, which has a nominal base clock of 350MHz, capable of hitting a maximum speed of 1.15GHz. While this obviously can't compete with dedicated graphics silicon when it comes to driving the very latest games, it does mean that you can build a machine without a discrete GPU, keeping both the price and size of the machine down.

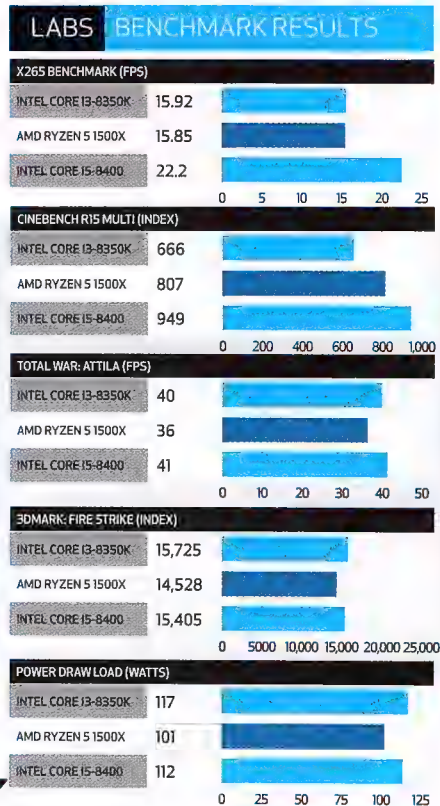
There is one small problem when it comes to that notion of budget, though, and it's that your options on the motherboard front are limited to a single chipset, and that's the enthusiast-class Z370. There is a surprisingly good spread of options here, but with even the cheapest starting out at \$170, we're

some way off the \$100 starting point that formed the basis of many a budget Core i3 build using the B250 motherboards from the previous generation. More budget-conscious chipsets should be on the way, but for now, the combo of this chip alongside the cheapest Z370 board starts out at around \$430 in Australia. Gulp.

Performance, however, is great. That high base clock speed combined with four real cores makes for some great results. Indeed, in testing, this chip was just a shade off the performance offered by the last-gen Core i5-7600K. Here, we've compared it to the closest priced chip from AMD, the Ryzen 5 1500X, which is a quad-core chip as well, albeit with Simultaneous Multi-Threading, so it can handle eight threads. It's a neck and neck fight, with the added threads of the Ryzen helping it to win in some areas, but the raw grunt from Intel's single-core performance trumping Team Red elsewhere.

When it comes to overclocking, we managed to get our silicon running at 4.9GHz, with only a little extra voltage (1.4V), resulting in a Cinebench score of 784 (with a single-thread score of 205). Impressive figures.

The real problem for this unlocked Core i3 is Intel's own Core i5-8400, a chip that costs just \$20 more, yet boasts 50% more cores. The Core i5 also has more cache and a lower TDP. Of course, you can't overclock that chip, which is a definite win for the Core i3-8350K, but on balance, we'd still prefer to have the extra cores. ■ Alan Dexter



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Expensive, but with some impressive performance and great overclocking potential.





2-IN-1

FROM \$2,299 | WWW.HP.COM/AU

HP Spectre x2

A stylish and powerful Microsoft Surface Pro competitor.

Previously posited as an affordable alternative to the Surface Pro, this latest iteration of the Spectre x2 is now anything but. Starting at an aggressive \$2,299, the Spectre x2 intimidates with more than its gold-and-black aluminium finish.

The Spectre x2's price isn't bad when you consider its spec. The model tested here has a 2.4GHz Intel Core i7-7560U processor, 8GB of RAM and 360GB of solid-state storage. Pair that with a 3,000 x 2,000 display, and you have a better-than-competent slate.

Trimmed with a gold stand and a chic logo to match, the HP Spectre x2 is a design feat. It's a near bezel-less beauty that destroys the notion that gold is gaudy. In fact, none of the issues you'll experience here have to do with this 2-in-1's form.

The trackpad is wide and functional, but it ultimately overstates its welcome.

Don't think about seating this tablet even slightly off the edge of your table or desk. On our review unit at least, the Spectre x2 can be audibly and haptically clicked on both the left and right-hand side areas on the outside of the trackpad. You can imagine how much of a nuisance this can be.

Aside from that, it's a joy to use. The stunning display is noticeably more vivid than that of the Surface Pro, not to mention the Active Stylus Pen and magnetically attached keyboard, which are bundled in the package. Plus, there's a microSD card slot, headphone jack and two USB-C ports.

There are two cameras on-board — one regular webcam and an infra-red sensor for Windows Hello facial recognition-based logins. The latter works well, despite you having to sometimes reconfigure it.

It's a miracle that the Spectre x2 comes with a stylus at all, yet we have to complain where it's due. This isn't the Surface Pen.

This is the HP Active Pen, a dual-button writing and drawing tool that supports only 2,048 pressure points of sensitivity, as opposed to the 4,096 of the Surface Pro.

The 2-in-1 Spectre is handsome and powerful. Its i7 processor doesn't boast quite as much horsepower as the newest Surface Pro, though. In our 3DMark Sky Diver test, the Spectre x2 scores 4,238 compared to the Surface Pro's 6,431. While in the more CPU-centric Cinebench test, the Spectre x2 scored 351 points compared to the Surface Pro's 414. That's not to say the Spectre x2 is lacking, only that HP has opted for a more conservative i7 chip than Microsoft. This is likely an effort to keep costs down. It still performs better than the Intel Core i5-equipped Lenovo Miix 510.

The more important question is, how long can you use the Spectre without its clunky power adaptor? Unfortunately, not long — just 2 hours and 40 minutes, according to our PCMark 8

Conventional battery life test — a simulation of normal productivity tasks. More demanding tasks, such as video editing, will kill the battery faster, making this a tablet you'll have to keep plugged in most of the time. It certainly can't keep up with the Surface Pro, which lasted 4 hours, 3 minutes.

The Spectre x2 is clad with darling looks that distinguish it from the competition. The scrupulous trackpad and pedestrian battery life make the Spectre x2 a chore to use on the go. But it's definitely an attractive option for those looking for a Surface Pro-alike for less. ■

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

The HP Spectre x2 is one of the best Windows tablets ever made. Only poor battery life lets it down.





GAMING LAPTOP
\$2,998 | WWW.ASUS.COM/AU

ASUS RoG Strix GL503VS Scar

Can it make the first cut in genre-specific gaming laptops a deep one?

ASUS's wafer-thin Max-Q poster boy, the RoG Zephyrus, was one of the most desirable gaming laptops of 2017, but all its innovation came at a considerable \$5,000 cost, landing it well outside an affordable price bracket for the vast majority of gamers. While in many respects, ASUS's RoG Strix GL503VS Scar is clearly in a different league, it has enough powerful components to achieve comparable performance, and at around \$2,000 less.

An expectedly powerful Intel Core i7-7700HQ CPU is supported by a hefty 32GB of RAM (double any other unit we've recently tested) and a speedy 256GB NVMe SSD and 1TB HDD storage setup. The additional RAM does boost general computing tasks, with the device performing 16% better than the Zephyrus (see APC 445, page 24)

in PCMark 10 benchmarks, but it basically doubled the media encoding speeds of any other laptop we've tested with the same CPU and 16GB of RAM. This surprising power boost did come at a cost, though, pushing the device to 100°C. We didn't observe any throttling, and performing intensive media encoding processes was the only task that pushed the Scar above 94°C, but if sustained over a long time, that will damage internal components.

The Scar is a variation of the GL503VS and GL503VS Hero models from the RoG Strix range, one that ASUS claims is specifically designed for FPS gaming. We are a little skeptical of this new marketing convention, since the optimum requirements of a MOBA or FPS game will vary dramatically from title to title. You can generally say that a MOBA will require less GPU power and this

point of difference is the main distinction we've noted in the MOBA configurations available. Looking at the GTX 1070 GPU, the 32GB of RAM and the 144Hz 7ms response IPS display, this laptop offers an exceptionally well structured config for people looking to play graphically demanding games at a competitive level, FPS or otherwise. When it comes to real-world game tests, the Scar gets 79, 44, 46.4 and 91.22fps averages in our benchmarks *The Division*, *Far Cry Primal*, *Ghost Recon Wildlands* and *Rise of the Tomb Raider*, respectively. Compare this to the RoG Zephyrus' 84.9, 51, 52.6 and 94.3 respective averages and you see just how close the GL503VS's GTX 1070 GPU performs against the latter's Max-Q GTX 1080.

Those components heavily tax the battery, though, with the Scar lasting less than 2 hours when playing

movies and only 1 hour and 22 minutes in PCMark 8's Home benchmark. The system is also set to use passive cooling when on battery power (which curbs performance rather than engaging fans), so this isn't a system you'll be able to game on without being attached to power. That said, if you are OK with a very portable 2.5kg gaming rig and 144Hz screen combo, then this powerful device is one of the best gaming laptops we've tested under \$3,000.

Joel Burgess

Verdict

Features
Performance
Value

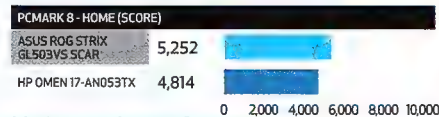


A performance-first gaming rig that bundles some of the best components for a great gaming experience.

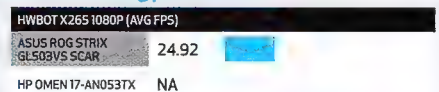


LABS BENCHMARK RESULTS

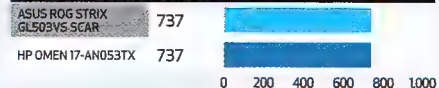
General performance



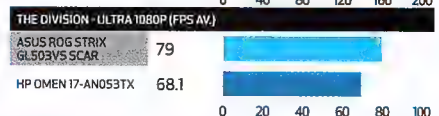
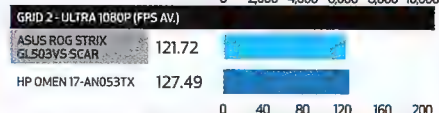
Media encoding performance



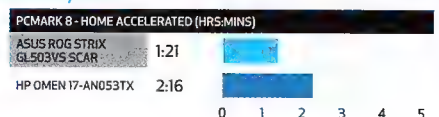
CINEBENCH - MULTI-THREADED CPU



Graphics performance



Battery life





GAMINGPC

FROM \$3,999; \$4,999 AS TESTED | WWW.ALIENWARE.COM.AU

Alienware Area 51

Unlike the real Area 51, Alienware's is hard to miss...

Alienware does its best to make its systems look like they arrived from a distant solar system, but the Area 51 desktop takes this aesthetic to new levels with a patently huge 'alien mothership' chassis that weighs in at 28kg. At first, we found it a little hard to fathom how a conglomerate of computer components could ever amount to something that may need a structurally engineered desk to support it, but this no-compromise config is made by its bandwagon of weighty optional extras.

The hero of this martian monolith is an Intel Core i7-7820X CPU, a rejigged Skylake processor that'd set you back around \$800 outright. This chip is one of the first consumer desktop CPUs from Intel to offer more than the usual four cores and while it's not quite as good value as the less-expensive Coffee Lake chips that have started to emerge, the i7-7820X still has an

edge when it comes to raw computing power. Up against MSI's latest living room PC, the Vortex G25 (see APC 450, page 22) – the first device we saw with a six-core desktop CPU (the Core i7-8700) – the Area 51 scored 41.7% better in Cinebench's multithreaded CPU benchmark. This raw power was further demonstrated in HWBOT's X265 1080p media encoding benchmark, where it averaged just over 64fps, the highest score of any pre-built desktop we've tested. A lot of the gains on the i7-7820X come from the fact that it simply has more cores than the i7-8700 (the Cinebench single-core scores, for example, are almost identical for the two), but this CPU has also been opened up to overclocking and comes with custom Alienware software to help make maxxing-out your CPU performance easier.

Behind this monster CPU is a hefty 32GB RAM

allocation and a Nvidia GeForce GTX 1080 with 8GB of VRAM. These components combine to dominate modern games on 1080p Ultra settings, with fps averages of 98.9, 87, 59 and 123.72 on *The Division*, *Far Cry Primal*, *Ghost Recon Wildlands* and *Rise of the Tomb Raider*, respectively. These scores are between 6% and 58% better than the Aorus X7DT (see APC 447, page 24) which ran on a Core i7-7820HQ, 16GB RAM and a mobile GTX 1080. So you shouldn't have any concerns about running a 4K or 240Hz monitor with a setup this powerful. That said, when you're paying 4.5 grand for a desktop, you're expecting it to have good performance – and if you really need a PC this powerful, chances are you'd be more than capable of piecing one together yourself for a fair bit less.

Unfortunately, the model we tested only included a small 256GB SSD. Sure, that's a speedy PCIe connected drive, and there's

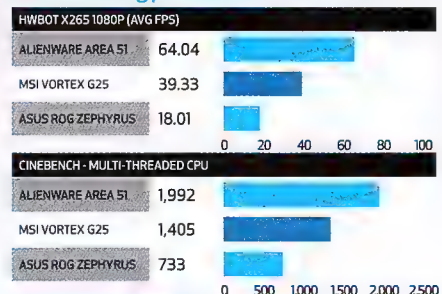
an additional 2TB HDD, with three spare bays for ad-hoc storage additions, but it's a bit rich to charge an additional \$200 to upgrade to a 512GB SSD for a PC at this price. There are the additional perks of liquid cooling, a 1.5KW power supply and the Alienware Command Center software that should allow you to push this system to its theoretical limits. And the case pops open easily, the vents have ample space for airflow and the ports are easily accessible and even include their own lighting system. But the price still hurts. ■ Joel Burgess

LABS BENCHMARK RESULTS

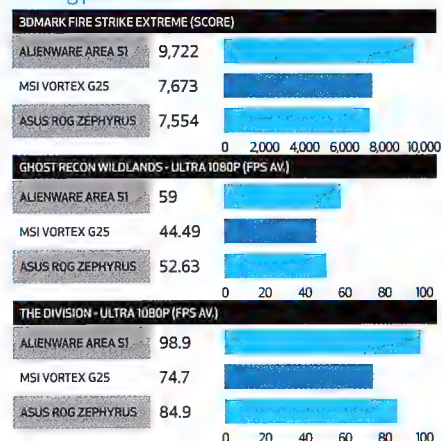
General performance



Media encoding performance



Gaming performance



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A monstrous powerhouse offering a suite of high-end components, but you're paying a premium.





CHROMEBOOK

\$849 | WWW.ASUS.COM/AU

ASUS Chromebook Flip C302

The premium Chromebook is finally affordable. Hats off to ASUS!

The premium Chromebook is a concept that has existed for almost as long as Google's notebook brand itself, and it's one that rarely found the legs to succeed. ASUS has finally come out with a premium Flip model that matches the competition on specs, but undercuts them on price.

At \$849, it's firmly in the laptop mid-range price point, and there are reasons for that: manufacturers are trying to drag the Chromebook market out of its seemingly permanent budget doldrums.

Like the original ASUS Chromebook C100 before it, the C302 is built from an all-aluminium chassis; though, this time, it has an anodised finish rather than a brushed texture. Overall, it has a clean, no-nonsense aesthetic and it folds up to a nearly symmetrical slab of metal.

The original C100's long, bar-shaped hinge has been dropped for the ZenBook Flip UX360's multi-gear,

metal mechanism. The smaller mechanism makes this machine feel like less of a toy and helps it to blend in as a regular notebook.

Aside from being lighter, the C302 seems to have been specifically designed for tablet use. ASUS has come up with a clever magnetic clasp that pulls the screen lid tight against the underside. It's an ingenious addition that helps the 2-in-1 feel like one solid device rather than foldable electronics, and we're surprised that this solution hasn't come sooner.

When you're not using the C302 as a tablet, it falls back on a solid keyboard that makes it as familiar and comfortable as any traditional laptop. The keys offer a satisfying 1.4mm of crisp key travel that we've missed in a world of ever-slimmer notebooks. The trackpad offers accurate tracking, but few multitouch features. There's nothing noteworthy here.

Intel Core M-series processors seem perfect

for powering Chromebooks. The benchmark results demonstrate this: Octane, 21,900; Mozilla Kraken, 1,276ms; and JetStream, 123. The Intel Core m3 performs nearly twice as fast as the Dell Chromebook 13's Celeron CPU.

Chromebooks are famous for their long battery life, and the C302 is the longest-lasting premium model we've tested yet, running for 10 hours and 46 minutes on our standard local movie playback test. With our regular everyday workload, the C302 ran just shy of hitting the 8-hour mark.

The display is 1,920 x 1,080 Full HD and it's all you need on a 12.5-inch screen. It's not as sharp as the QHD HP Chromebook 13, but the lower pixel count affords two more hours of battery life – a trade-off we'll gladly take. Photos and text look plenty crisp as is, and the C302 resolves strong colours, which is exactly what we're looking for in a companion device to flip through comics and stream

videos. Audio-wise, the Chromebook Flip's speakers are loud, but lack much nuance to really appreciate music. There's also a hint of tininess that limits how high you can set the volume before it's unbearable, so use headphones if you're looking to rock out.

This is the first 2-in-1 Chromebook that genuinely feels as comfortable to use in tablet form as it is in its traditional laptop mode. Until we see the Samsung Chromebook Pro with its sharper screen and built-in stylus, the ASUS Chromebook Flip is king of the Chrome OS hill.

■ Kevin Lee

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Worthy of its premium stature, with a classy design that's as easy to use in tablet mode or as a traditional laptop.



THE
MOST FUN
YOU CAN
HAVE WITH
YOUR HANDS
WITHOUT
GOING
BLIND



32-INCH MONITOR

\$1,299 | WWW.BENQ.COM.AU

BenQ PD3200U

A very large 4K screen for your desk.

With PC graphics cards becoming increasingly powerful, using a 4K Ultra HD monitor is an increasingly viable option, and the BenQ PD3200U is an excellent example of a 4K screen for both business and pleasure.

At such a high resolution, you need a large screen to avoid having to squint at tiny text and minuscule icons, and with its 32-inch diagonal screen size, the BenQ PD3200U provides that while avoiding being obnoxiously large. It's never going to be a 'budget' proposition; however, at \$1,299, it's actually pretty reasonably priced.

The PD3200U looks simple yet elegant. It's clear this is a monitor made with work and productivity in mind. It might be big, but it doesn't feel it, thanks to its thin bezels. Its footprint is reasonable, too, so it doesn't feel like it's taking up an inordinate amount of space on your desk. The supplied stand can be put together

and attached to the screen without the need for any tools, and its neck is fully adjustable. The screen can even be rotated 90° into portrait mode.

On the right-hand side of the monitor are two HDMI 2.0 ports, a DisplayPort 1.2, a mini DisplayPort, SD card slot, two USB 3.0 ports and a 3.5mm audio port. With HDMI 2.0, you can now use HDMI to display 4K visuals at 60Hz, which means you can also plug in a PS4 Pro or Xbox One X and use it as a display for those.

As far as features go, the PD3200U's main selling point is its 3,840 x 2,160 resolution, which provides excellent image quality. The 32-inch screen size ensures that text, icons and other visual elements aren't too small, with the pixel-per-inch count coming in at a comfortable 137.68. The panel type is IPS, with a native contrast of 1,000:1. This ensures viewing angles are very good.

BenQ is pitching this as a pro monitor, and the 100%

sRGB colour gamut adheres to industry standards. It also meets Rec. 709 video production specs. It also comes with a range of modes for professionals, such as a CAD/CAM mode, which ups the contrast for lines and shapes in technical illustrations. It also includes Low Blue Light and Flicker-free technology, making it more comfortable to use at night. Animation Mode boosts the brightness of dark areas without over-exposing light areas of an image, while Darkroom Mode, enables you to work comfortably in dark environments.

In use, the BenQ PD3200U is very impressive. Images and videos look excellent. If you're buying this as a business monitor for your work, you'll be impressed with its performance, especially considering its price. But what about performance for non-professional applications? The PD3200U supports HDR, which, along with the HDMI 2.0 support, makes this a

viable screen for 4K games consoles and UHD. Although the 60Hz refresh rate won't impress gamers used to higher refresh rates and G-Sync or FreeSync tech, if you're playing modern games at 4K, 60Hz is all you need. Its 4ms response time is on the slow side, though.

If you're looking for an excellent high-res monitor with accurate colour reproduction, which can also do a good job of displaying films and games, and can also be a great help in boosting your productivity, this is a great choice. Other monitors feel claustrophobic by comparison. ■

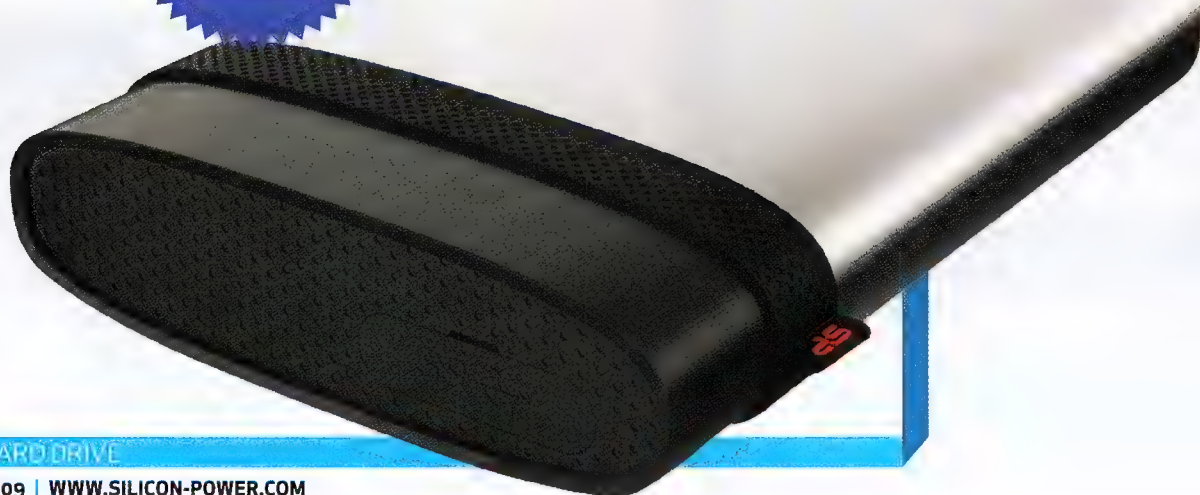
Verdict

Features
Performance
Value



The BenQ PD3200U is a fantastic 4K monitor, suited to home and professional applications alike.





USB HARD DRIVE

FROM \$109 | WWW.SILICON-POWER.COM

Silicon Power Armor A85

Portable storage that can take some serious knocks.

The Power Armor A85 may look like a hip flask, but it's actually a portable external hard drive that's been built to be abused beyond all reasonable expectations. It's dust- and waterproof to IP68, shockproof, drop-proof to US military standards (up to 3m) and is pressure-proof, too.

The 1TB model on test here sells for around \$109. It's also available in a 2TB capacity in Australia, for \$169. It comes with a 32cm-long USB cable that has Type A super-speed connectors at both ends — useful, just don't lose it, as it's not a common cable. The USB Type A port on the drive is hidden under a thick plug on the black cap end that incorporates a tight rubber seal. The plug looks good for keeping unwanted water and dirt out of the drive, but it's also an excellent route to breaking a fingernail trying to pop it out. Then again, it's built to handle abuse rather than win any style awards.

On one level, the A85 is just a hard drive stuffed inside a thick metal tube. However, that thinking ignores the tricky technical details the Silicon Power engineers had to resolve to make that work — like avoiding overheating, and cossetting the drive from accidental assaults of water, dust and the general trials and tribulations of careless ownership.

It survived the MIL-STD 810G Method 516.6 Procedure IV, aka the transit drop test, where you perform 26 drops on each face, edge and corner from a height of 122cm above the floor. And all those test drops can only be divided among five test items. The device must also survive a single 3m drop test and still be functional afterwards.

Having compliance to IP68 means it should be dust-proof and protected against immersion in water for more than 30 minutes at a depth of up to one metre.

The Armor A85 certainly talks the talk, but can it

walk the walk? Silicon Power has previously used Seagate's Momentus hard drives in its products and we suspect that's what's inside here, too. We only got to test the 1TB model, but the same outer shell is used with drives up to 5TB.

Performance isn't SSD level, but it's more than acceptable when compared with many portable drives that use conventional tech.

In our benchmark tests, CrystalDiskMark rated the read speed at 119.3MB/s and writes at 118.4MB/s. To achieve those levels, you'll need a USB 3.0 connection with USAP mode active.

Normally, the suppliers of review kits expect us not to intentionally abuse their devices because they'd like it back at some point. However, Silicon Power specifically told us to get the A85 wet and, unbelievably, drive a car over it. So post-benchmarking, that's what we did. Unsurprisingly, the car exercise did leave some minor abrasions on the drive but that didn't stop it from

working. It also survived complete immersion in water, though it's worth noting that it doesn't float.

This isn't the quickest external drive we've tested, but it's undeniably one of the toughest. If you're taking a trip where data loss might result from dust or water, then this is an affordable solution.

The only significant caveat is that dropping it into anything other than shallow water could be its undoing. The only other issue concerns the unusual twin-ended USB Type A cable, which could be difficult to replace if you lose it. ■

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

A USB 3.0 portable drive that performs reasonably well, and under the toughest conditions.





PC SOUNDBAR

\$499 | AU.CREATIVE.COM

Creative Sound BlasterX Katana

Sleek and powerful, this PC soundbar impresses.

This is a soundbar for pairing with a PC monitor that creates 2.1 audio – using a separate, wired subwoofer – and offers a whopping 75W of power.

The Katana has a robust build quality. Measuring 59cm long, it has two small feet, which create about a centimetre of clearance, giving it a pleasant floating look, and it's angled slightly up towards you. Audio-wise, that's an excellent design, while on each end, there's a separate 7cm speaker grille that enables it to project sound slightly to the sides. Despite its heavyweight feel and 1.5kg bulk, it looks super-sleek, with a height of just 4.5cm, depth of 8cm, and a black, brushed aluminium finish. It also comes with an Aurora Reactive Lighting System, which is made of up 49 programmable LEDs that can display up to 16.8 million colours – perfect for creating ambient lighting.

Physically, the Sound BlasterX Katana is a little

difficult to house on a desktop, as the subwoofer must be tethered to the soundbar using a relatively short 2m-long cable. On its rear, you'll find a subwoofer connector alongside inputs for a mic, 3.5mm auxiliary input, digital optical audio input, USB and Micro USB.

The promised 7.1 virtual surround sound effects can scarcely be heard. The overwhelming impression is one of volume. The Katana handles game soundtracks and music well, with plenty of mid-range and bass, although treble detail is its defining characteristic.

It leaves you wanting less, not more, with its volume and bass levels potentially a little overwhelming when heard at close-range on a desktop. ■

Verdict

This incredibly loud soundbar impresses, although its space-saving design is slightly flawed.



PC HEADSET

\$69 | WWW.LOGITECH.COM/AU

Logitech G231

Just because you can, doesn't mean you should...

Logitech has earned itself a legacy against which very few others in the PC peripherals market can compete. However, here we have a prime example of when things don't go quite right.

Simply put, we cannot recommend the G231 headset. Let's start with the good: from a distance, it looks great. Now the bad!

The G231 lacks any definition in the upper end of the treble. The muffled cries of artists feel hidden, almost smothered by the dominating thrum of overpowering bass notes. Definition of sound is lost for the sake of gaming prowess and awe, if you can call it that.

As a whole, the design isn't actually too bad and it follows Logitech's somewhat meticulous styling. The problem is the materials employed. The plastic feels cheap, with a soft sheen and a sense of snappability. Couple that with a very similar feeling microphone

boom mechanism, and the G231 simply doesn't sing itself any praises.

We're not just saying this because we're used to triple-digit priced cans. The G231 doesn't even hit the mark compared to products at the same price point. Take SteelSeries' Siberia 150, for instance. The cheaper 150's soundscape is clean, refined, with no heavy emphasis on bass. There's less material there, too, but what there is feels flexible and strong, and the more abrasive finish on the headband feels more premium.

In the end, if all you're after is a headset purely for gaming, and your budget is tight, the Logitech G231 is fit for purpose. It's not the best, but it does the job.

■ Zak Storey

Verdict

Huge bass footprint ensures poor driver clarity, and the flimsy materials give it an ugly finish.





PC CASE

TBC (~\$120) | WWW.BITFENIX.COM

BitFenix Enso

A PC case for when RGB is life.

There's a facetious argument going around the tech industry that says RGB sells, therefore more RGB must be added to more products. The problem we have with that argument is that, if anything over 50% of the products out there feature RGB, then of course RGB is going to sell more. It doesn't necessarily mean that it's more popular, just that you have more RGB products than non-RGB. And as a consumer, if you're left with just one choice, what other option is there?

BitFenix's Enso looks to capitalise on that growing 'demand' for all the red, green and blue, with what can only be described as the world's most boisterously disorderly LED-lit chassis. Featuring four individual LED RGB strips baked into the corners of the front panel, each vertex glows with an incandescent rainbow wave, for those who desire it, or full individual colours if you're after the

thematic colour-matching look instead. There's no software control here, but instead, a single button is located on the front I/O to cycle through all the lighting effects. Although RGB cases are few and far between, we have seen similar features in the past. Typically, however, these only extend as far as an individually lit logo or power button, not a fully lit wavy design embedded into the front of the case. You're either going to love it or hate it, and for those who love it, it's going to be a welcome addition to an already extensive customisation option. For the latter? Well, this probably isn't the case for you.

The Enso should sell for around \$120 when it lands in AU, and for that you net yourself a mid-sized ATX tower packing all of that RGB, plus a tempered glass side panel, a PSU cover, SSD mounts and plenty of cable management. There's some smart slide-out fan filters included on the right-hand

side, as well as a magnetic soft-touch dust cover, or mesh filter, for the top two 120mm fan mounts.

However, it's not without its problems. By far the biggest is airflow. The front of the chassis lacks any major source of air intake, with only scant access being available from a small two-inch cutout situated at the bottom of the front panel that draws air in from the back of the chassis, funneled through two channels around the feet. The inclusion of some form of mesh intakes along the edges of the front panel would help alleviate these worries considerably. Unfortunately, that single two-inch cutout just isn't enough to ensure the front fans are adequately fed.

Then there are the materials used. There's just too much plastic and steel for our liking. Sure, you get yourself a lovely tempered glass window and some smart lighting, but when you consider that Phanteks provides both of those in its

Eclipse P300 for just \$80, you have to ask what you're actually paying for. There's no soft-touch finish, no premium coating — everything has been thrown under the bus in order to hit that price point and show off the LED innovations embedded within.

If this came with a single white LED, better airflow in the front, and a premium finish at the same price, we could get behind it. Unfortunately, as it is, unless you live in Fargo, North Dakota, and really love wavy illuminations, this chassis is probably best ignored. ■ Zak Storey

Verdict

Features	★★★★☆
Performance	★★★★☆
Value	★★★★☆

Well equipped and with copious RGB; but with awful cooling and cheap materials.



software

» APPS FOR ALL THE PLATFORMS



Windows SOFTWARE

Adobe Photoshop Elements 2018

Adobe's wallet-friendly image-editing app gets its regular yearly update.

\$149.95 | WWW.ADOBE.COM/AU

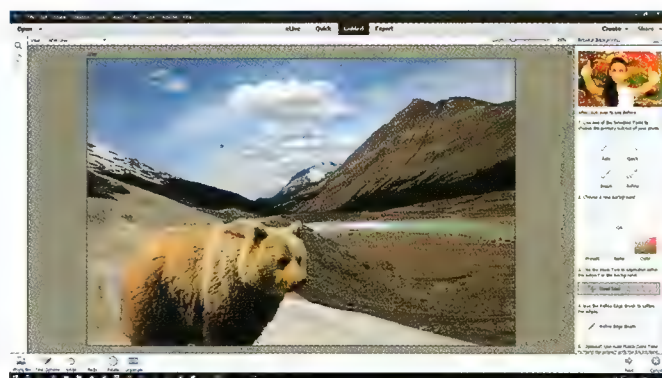


Suitable for newcomers, the enthusiastic amateur photographer or even those pros who don't care about things such as CMYK or 16-bit colour, Photoshop Elements is a photo editing program that punches above its weight. The package includes 90% of Photoshop's most useful features for a single fixed price, rather than an annual subscription and is available as a standalone app or in a bundle with its video-editing brother Premiere Elements.

The Elements interface basically remains unchanged since version 11, which was released back in 2012. So the Editor modes include the usual suspects: Quick, Guided, Expert and Camera Raw. As is often the case, the new features are mainly found in Quick and Guided, although Expert does benefit from a new auto-selection tool that should take some of the frustration out of selecting areas with detailed edges.

It works well; dragging a square around an object in your image triggers a short pause, followed by the familiar marching ants outline of a selection. We tried to confuse it with a brown bear against a brown backdrop, but it homed right in on what we wanted. There was a bit of backdrop retained between the bear's legs, but nothing we couldn't sort out with a few clicks.

The Auto Curation element has added the ability to choose the best out of a group of photos. It's activated with a simple checkbox at the top-right of the Organizer interface, and as you might expect, is quite processor-intensive, especially if



you import a large photo library. The app also creates a slideshow from the photos Auto Curate selects, so you can show off your skills to family and friends with little to no interaction on your part.

Elements gets better every year, but the changes are never big enough to make current users upgrade immediately. For new users, it's a compelling package, but Affinity Photo, the challenger to Adobe's crown, is less than half the price for a package that concentrates on editing, rather than organising and automation. For its target audience, Elements 2018 is the best all-round photo-editing app. The new Guided edits enable spectacular transformations of photos, while gently teaching you how the app works. **Ian Evenden**

PDF-XChange Editor

The best free Windows tool for editing text in PDFs, with built-in OCR.

FREE, PLUS EDITION, US\$54.50 | WWW.TRACKER-SOFTWARE.COM



If you need to edit the text in a PDF, PDF-XChange Editor is ideal. It lets you retype, delete and reformat text, and adapts well if the document uses a font that isn't installed on your PC. You can also attach comments, split PDFs and extract pages all using the basic free version.

One of PDF-XChange's best features is the ability to use OCR to recognise text in scanned documents — ideal if you only have a printout rather than the original file. From here, it's only a one-step process to export a PDF into a Word document.

Note that some of the features visible in the menus and toolbars are only available in the premium 'Plus Edition' version, but rather than restricting you from using premium features like adding polygonal shapes or new text boxes, for example, your document will instead become



watermarked. If you do need to convert something you need to be presentable, just hover your mouse-pointer over an icon to find out if it's an included free feature or not. **Cat Ellis**



Scrivener 3

Fall in love with writing all over again.

\$69.99 | LITERATUREANDLATTE.COM



Scrivener is an app for writers who need to write big things — say, dissertations or novels. It's not just a manuscript editor, although it's a good one. It's not just a publishing tool, although it's good

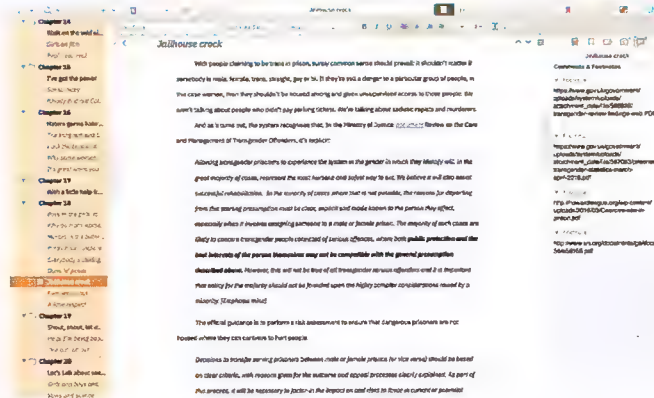
at that, too. And it's not just a place to store your research, although it's damn good at that, as well. It's a writing companion that's with you from the first spark of an idea to the final edit.

We'd used Scrivener 2 to publish a novel, so decided to give Scrivener 3 something even more meaty: 107,422 words of non-fiction across 50 chapters, hundreds of footnotes and gigabytes of background, and a brand-new project that meant collating research and testing different structures.

The revamped, simplified interface is superb, and superbly customisable. There are many stats and targets and custom metadata you can mess around with when you're supposed to be working, too. For example, you can see how much you write each day, or create checkboxes to indicate whether you've sent a piece to the publisher.

The templates are really great, and they are customisable, as well. The Compile dialog for exporting and publishing, previously rather awful, is now streamlined, sensible and speedy. The improved Kindle support and ePub 3 compatibility are great for self-publishers.

The new Bookmarks feature makes it easy to access frequently used documents, and a Dialogue Focus mode can



highlight all the direct speech in a block of text. Scrivener can also do Markdown, loves Dropbox, and syncs with its separate, equally great iOS app. Like to organise ideas using a virtual corkboard or an outliner? Both are available.

Managing annoying things such as footnotes and citations is near effortless, as is removing unnecessary spaces and tabs, and other important but usually tedious tasks. There's also great Touch Bar support if you're that rare breed — a writer who can afford a new MacBook Pro. Scrivener 3 is also incredibly quick and stores your text as text, meaning you're not stuck with a proprietary format.

We wouldn't use Scrivener for quick-and-dirty writing gigs, such as blog posts or opinion pieces — our go-to remains Ulysses for that — but for anything more ambitious, especially involving managing characters or background research, all kinds of documents, and the kind of 3am ideas that have you reaching for a notepad in the small hours, Scrivener is an absolute joy. Writers: if you buy this app, your life will be better. **Carrie Marshall**

BBEdit 12

Powerful text editor improves again.

US\$49.99 | BAREBONES.COM



Version 12 of BBEEdit arrives 25 years after the original — that's some achievement. Thankfully, the app remains relevant, powerful and efficient.

New features include improvements to the FTP view (you can now open/close folders), the ability to paste using a text filter, and support for Split View, so you can have a Markdown document on the left and a preview on the right, with the inspector below.

Our favourite new features are Columns Editing and Canonise. Columns Editing is for comma- and tab-delimited text files. You can copy one or more selected columns to a new document, or rearrange columns without a copy-and-paste dance with a spreadsheet app.

Canonise is a superb batch search-and-replace tool for multiple text strings. You define required changes in a bespoke file, which is then applied to other documents.

The app remains absurdly powerful. We opened a 150MB text dump in BBEEdit on a wheezing Mac mini, which took a short while, but a find and replace of 789,097 changes occurred in a blink of an eye. BBEEdit offers a great mix of power and reliability for a whole range of users, for writing, editing or coding. **Craig Grannell**

Elements+

Get more from Adobe's Photoshop Elements.

\$17 | ELEMENTSPUS.NET

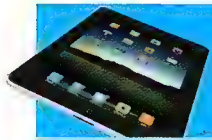


Photoshop Elements is great but there are some common complaints about it. In particular, as you advance through its guided edits and tools, your ambitions as an editor advance, too, only to be stymied by its constrained set of features. Elements+ claims there are loads of features buried within Elements that can be freed up with a few lines of code.

Among the benefits is a traditional Curves tool, applied as an adjustment layer, a proper Quick Mask mode and a comprehensive selection of Smart Object commands — all accessed through Elements' Effects panel. You can create paths from selections, text layers and vector masks, brilliantly addressing a major omission. There is also a good set of scripts available, including focus stacking.

Admittedly, navigating the tools does take a little getting used to — they don't sit with Elements' regular controls — but there's absolutely tons here.

Elements+ is well worth a look if you're not a Creative Cloud subscriber, or simply love Elements too much to leave. **Dave Stevenson**



App Store » iOS APPS

Yoink

Give a boost to a key iOS feature.

\$4.49 | ETERNALSTORMS.AT



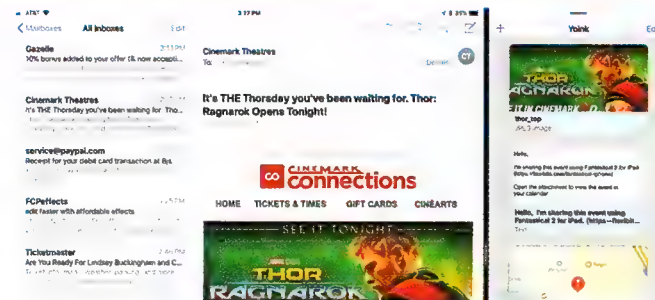
Pad users around the world rejoiced when Apple announced drag and drop in iOS 11, but as with any new feature, there's always room for improvement. Sure, we can finally copy items between different apps, but why not go a step further by adding the option to temporarily save items you'll want to use again? That would be really handy.

Thankfully, that's the premise of Yoink, a virtual storage shelf that enhances iOS 11's drag-and-drop functionality. It's not a clipboard manager in the traditional sense — apps like Copied are still best suited to that particular task — but you can drag images, text clippings, web addresses and other files into the app, and then preview, rename or organise them into stacks, which are the equivalent of folders on the desktop.

After debuting on the Mac four years ago to rave reviews, Yoink for iOS was designed first with iPad in mind, particularly in Slide Over or Split View modes alongside other drag-and-drop compatible apps. But the developers also found a way to bring as much functionality as possible to the iPhone, which doesn't support inter-app drag and drop.

New items can be imported from the current Clipboard contents or Photos and Files browsers, methods that work on the iPad as well. There's also a Share sheet extension for adding content directly from other apps, as well as a keyboard that allows you to paste items from your Yoink library wherever text can be entered, such as Mail or Notes.

A lock button in the lower-left corner governs what happens when items stored in Yoink are dragged out of



the app. Leaving the button unlocked moves the file, clearing it from the shelf at the same time; locked mode copies the item instead, preserving the original for later use. This gives you the option to use the app as temporary or permanent storage.

Everything saved in Yoink is also indexed by Spotlight, making it easy to search for a specific item even while the app is closed. Integration with iOS 11 is about as tight as it can be in the circumstances, with one exception: there's no iCloud sync, so each device can access only its own saved content. Given that Yoink can store anything from a small snippet of text to a large movie file, this is an understandable limitation, but it would be nice to at least have the option.

Not every app plays nicely with Yoink all the time — we had occasional trouble importing PDF files that were originally from Mail attachments. This was a particular issue in Readdle's PDF Expert, which is otherwise a model of drag-and-drop compatibility. Worse, the same file vanished into thin air when we attempted to add it while Yoink was unlocked.

This bug aside, Yoink makes an impressive debut on iOS, and should be considered an essential addition to any iPad user's arsenal of truly useful apps.

JR Bookwalter

Grammarly Keyboard

So long, typos!

FREE | WWW.GRAMMARLY.COM

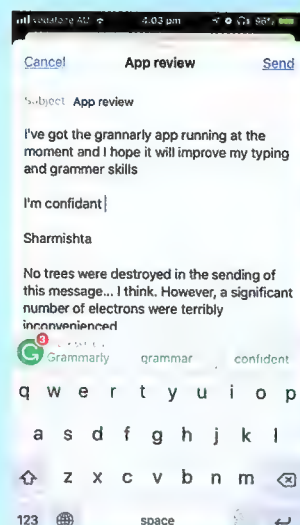
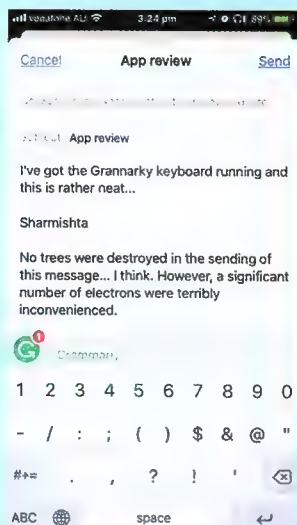


If you've spent a lot of time writing on a computer, you're sure to have heard of Grammarly, a tool that checks your grammar and spelling as you write.

There's a Chrome extension for anyone typing on Google's browser and Android users can access an AI-powered keyboard. The iOS version of the keyboard is now available, making it easier for iPhone and iPad users to type without worrying about errors.

The Grammarly Keyboard for iOS is similar to the standard iOS keyboard, with enough spacing for anyone suffering from fat finger syndrome. It checks for real-time grammatical errors, spelling and punctuation mistakes, and also provides a synonym finder. Typos are corrected on the fly while spelling errors alerts are visible. Selecting that on the bar above the keys automatically brings on the correct word.

Setup is easy — download the Grammarly Keyboard app, go to Settings and add the third-party keyboard. When you first begin to type, select the globe button on the default keyboard and select the Grammarly option. Finally, as Grammarly says, "type with confidence". Sharmishta Sarkar





Google Play » ANDROID

https://www.bing.com/search



tech life magazine



All Images Videos News

TechLife Magazine Subscription | Magshop

<https://www.magshop.com.au> » **techlife**

Mobile · TechLife makes computer technology, gaming and IT accessible to everyone. Get your **magazine** subscription Techlife at ...

[Australian Gourmet Tr...](#) [Contact Us](#)

[Australian Women's W...](#) [Gift Finder](#)

TechLife - Official Site

www.techradar.com » news » ... » **techlife-ma..**

Mobile · TechLife's Xmas issue has hit physical & digital newsstands across Australia: Here's what you can find inside!

Microsoft Edge

Microsoft attempts to dethrone Chrome on Android.

FREE | WWW.MICROSOFT.COM



Why would anyone use Microsoft Edge on their phone? It's a very good question. For anyone who's recently set up a Windows 10 PC and tried to install Chrome, Microsoft's modern internet browser seems a bit forlorn, a bit desperate to be given a go.

Should we pity-use Microsoft Edge on our smartphones, then? There are some reasons why you might at least try it. If you happen to use Edge on your Windows machine, the ability to access your favourites/bookmarks and browsing history on phone is handy – though Chrome does this, too. If you've got the Fall Creators Update, you can click an icon, connect to a device, and have all tabs and content transfer over to that PC immediately: undeniably useful, but hardly a game changer. Of course, you can use voice commands to search the web, and there's an Incognito Mode equivalent called InPrivate. After about half a day using this app intermittently, we encountered no problems. To be honest, it's actually decent, and feels far less bracing a change than Edge does on desktop. Is it better than Chrome? Maybe. Is it worth moving from Chrome? No. **Shaun Prescott**

Datally

Mega tight with your megabytes?

FREE | DATALLY.GOOGLE.COM



The subtitle given to Datally — a “mobile data-saving & Wi-Fi app by Google” — is about as close as you'll get to a spoiler in the world of utility apps. By tracking the daily data usage of each of your apps, Datally gives you a simple and informative breakdown of your mobile data usage throughout the day, week or month. It's an intuitive way to discover that, for instance, your highest data usage on a weekday is around lunchtime, and Spotify seems to be the main culprit. To rectify this, you can turn on Data Saver, which blocks any app from using mobile data in the background when not on Wi-Fi. Naturally, you can manage which apps are affected by this with toggle switches, and when actively using one of these blocked apps away from Wi-Fi, a small bubble will pop up showing how much mobile data it has used in your current session. There's a neat extra feature that lists any nearby public Wi-Fi points as well, with a shortcut that opens up Google Maps directions for each. **Harry Domanski**

Focus Go

The most stripped back photo gallery app you'll find.

FREE | TINYURL.COM/APC451-FOCUS



In his amusing-verging-on-unhinged

Google Play description, the creator of Focus Go explains that he doesn't like “bloated galleries with 23,093,485 features, so I only built the ones I need/think are needed”. And so it is with this app, which is notable only for all the things it doesn't do. It seems odd to seize on such a barebones app that completely shirks ‘innovation’, but you don't realise how much bloat weighs you down until it's gone. Focus Go simply displays your photos in chronological order, each month forming a new heading. There are three grid settings (basically big, smaller and tiny), and that's about all you need to know. It downloads in seconds and there's no need to sign in or sign up for anything. It's a little slice of paradise, in other words, and if you're sick to death of pressing through advanced functionality you'll never ever need, this is probably among the best ways to look at images on Android. **Shaun Prescott**





Linux » OPEN-SOURCE SOFTWARE

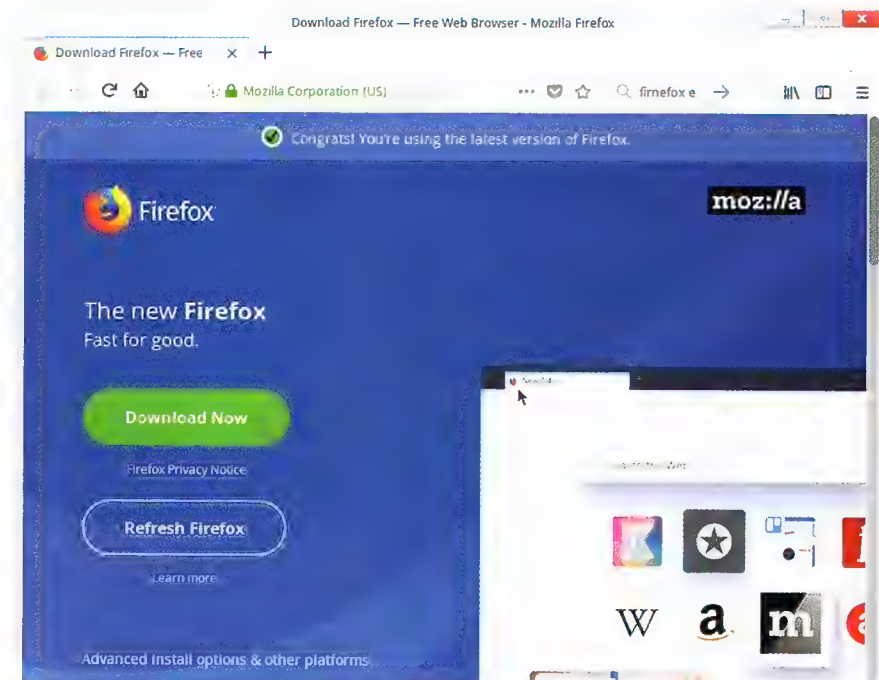
FLOffice

A nicely organised free office suite.

FREE | WWW.BIT.LY/2CA44PA

When Linux users ask us to help with the choice of an office suite, it's difficult for us to come up with a really intriguing offer, because everyone knows that it will still be LibreOffice. This is the most powerful and advanced set of office applications that proudly bears the banner of 'open source' around the world. However, no matter how developers optimise it, it still remains a big and resource-intensive package, which may not even work on old computers. Recently, small boxes like the Raspberry Pi have been gaining in popularity, and many people would like to be able to perform office tasks on these low-power devices.

FLTK Office Suite, or FLOffice for short, doesn't pretend to be a fully fledged alternative to LibreOffice or other productivity suites, but it adds very valuable features to minimalist Linux distros that commonly run on Raspberry Pi boxes by providing some basic office applications. It's much better than nothing, after all.



FLOffice is based on the FLTK library, where FL means 'fast as light'. You wouldn't notice a big performance gain on normal desktop machines, but on low-end devices, it really means a lot: FLTK-based apps are way faster than those based on GTK or Qt.

FLOffice has a 'home' screen or a shell – a central point with quick links to frequently used applications. The office suite itself bundles a text editor, a spreadsheet app, a maths formula editor, a picture viewer, a scanner tool

and a simple file manager, plus a bunch of less intriguing binary apps. The home screen, however, comes with quick links to some other applications that are not part of FLOffice, including: Chromium, AbiWord, XPaint, Rox and few more, which you are supposed to install yourself.

Once you set it up, FLOffice will be ready for everyday use. It proved to be quite handy and useful in our tests, and very light on resources.

Alexander Tolstoy

Minitube

Providing most of what you need from YouTube.

FREE | FLAVIO.TORDINI.ORG/MINITUBE

Long before Google presented its own mobile app for YouTube (and we got used to it on Android-powered handhelds), there existed a third-party attempt to change the way we watch YouTube videos on a desktop. Flavio Tordini was the author of Minitube, a desktop application that was designed to save you from common web distraction by offering a standalone application. Minitube is not a browser window that is wrapped to look like a desktop app: it is a fully fledged desktop app. Due to Google's requirements, Minitube needs a browser API key in order to use YouTube features. If you build Minitube from source, start with:

```
# make qt5 "DEFINES += APP_GOOGLE_API_KEY=YourAPIKeyHere"
```

Alternatively, if you install Minitube from your package manager, you can export the key as a variable:

```
# export GOOGLE_API_KEY="YourAPIKeyHere".
```

Grab the key at console.developers.google.com.

(You'll need a Google Account for that.) Using Minitube as an everyday tool for finding and watching videos is a delight.

The app is minimalistic yet feature-rich. The home screen has three main sections for searching video, watching trending or recommended videos, and viewing your subscriptions. It's possible to tell Minitube your preferred video quality, toggle safe mode and set the Autoplay feature on and off. Once you find something to watch, Minitube goes to a player mode, with the currently playing video in the main part and similar videos in the vertical bar on the left. Right-click over the video to access a menu with some extras. This lets you open the current video in a web browser, copy the link address to the clipboard and find similar videos. We had a great time with Minitube, as it set us free from ads and various undesired bells and whistles of the YouTube web page. It looks like a video player with a smart playlist where you can find anything, and it will be fetched in a second or two. Alexander Tolstoy

Finding the best Intel Z370 motherboard

Intel's finally gone beyond four cores with its new mainstream 8th-gen CPUs, but to put 'em to use, you'll need a new motherboard. The APC team test eight to find the best options.

Oh, Intel, you've done it again. Despite rumours that the 8th-gen Core CPUs would be compatible with the older Z270 chipset, once again buyers of new Intel chips also have to upgrade their motherboard. The new Z370 chipset is mandatory if you want to run Intel's latest CPUs, which basically doubles the cost of upgrading to the new chips.

Z370 still uses the Socket 1151 form factor, though, which means it's at least compatible with existing Intel coolers. Despite being an identical-looking socket, it's actually had more power delivered to the new chips, up from 128 VCC pins on the Z270 to 146.

The Z370 still has 24 lanes from the chipset and 16 dedicated to graphics, delivering an identical 40 to the Z270. It likewise has the same number of SATA 3 ports (six native), USB ports, and there's no sign of USB 3.2, just the usual 3.1 Gen 2. It's still using dual channel memory, with four slots, which now runs at DDR4-2666, up from DDR4-2400 in the Z270, a very minor increase. There's obviously support for Intel's Optane cache technology, though that doesn't seem to have been the hit that Intel expected. Most of the 'boards we tested using this chipset have the same audio chipset as the bulk of Z270s, as well – Realtek's ALC1220.

Basically, the only major change to Z370 is in the power configuration, as the six-core CPUs need more juice to power the extra two cores. Our major disappointment is the lack of extra PCIe lanes, as with the ever growing number of M.2 SSDs drives and high speed USB

ports, we're quickly running out of places to plug in our peripherals.

So how about those new CPUs? Formerly codenamed Coffee Lake, the 8th-gen Core CPUs are aiming to take the fight back to AMD where it hurts – multiple cores. We haven't seen AMD be this competitive for a long time, and Intel is in a bit of a mess about catching back up.

The below chart shows the new CPUs, and how Intel has increased the core count. Only the top two have 12 threads, as the i5s have had HyperThreading disabled. Intel claims up to a 43% performance increase in the six-core chips compared to the prior 7th-gen Core i5 and i7, but there's a catch. This increase is only true when running multithreaded applications that can make use of every single core and thread. When running a single thread, the performance increase is much smaller, measuring just 3% faster in our Cinebench single-thread benchmark. This is because Intel hasn't focused on increasing IPC per core – the goal with this chip was to simply get more cores

out there to take on Ryzen, with a slight frequency boost.

The K versions of the CPUs allow per-core overclocking, but we've seen this implemented on motherboards in the past. The integrated GPU is identical to Kaby Lake, but with a small speed boost.

As you can see, there's really not much new here other than the extra cores. The fact that Intel is re-releasing it with an improved architecture but under the same name shows just how much impact AMD's Ryzen has had on the CPU market. It's a wonderful thing to finally see Intel's CPU monopoly over, and it will be very interesting to see how Intel counters throughout 2018. Until then, though, it appears that AMD's Ryzen 7 is still the best option for serious multithreaders, while Intel has the lead in apps that only use a few cores.

Let's take a look now at eight 'boards that are based on the new chipset. We've gone for a generally mainstream price, so be warned – they're all quite similar, and performance was so close between them that we've dropped the usual benchmark charts, too.



INTEL 8TH-GEN CORE I CPUs COMPARED

	CORES/ THREADS	BASE CLOCK (GHZ)	TURBO ALL CORES/ONE CORE (GHZ)	L3 CACHE	TDP	PRICE
i7-8700K	6/12	3.7	4.3/4.7	12MB	95W	\$589
i7-8700	6/12	3.2	4.3/4.6	12MB	65W	\$479
i5-8600K	6/6	3.6	4.1/4.3	9MB	95W	\$399
i5-8400	6/6	2.8	3.8/4	9MB	65W	\$289
i3-8350K	4/4	4	N/A	6MB	91W	\$269
i3-8100	4/4	3.6	N/A	6MB	65W	\$179



\$239 | WWW.ASROCK.COM

ASRock Z370 Extreme 4

Affordability over functionality.

This is a considerably cheaper 'board than the Taichi (right), so it's to be expected that it won't have nearly as many features. And yet, in one way it feels more rugged, perhaps due to the ATX PCB being thicker, though ASRock didn't list this in the specs.

This ATX 'board comes with three PCIe x16 physical lanes, and another three x1 lanes. Two of the full length lanes are steel reinforced, which has become a feature found on pretty much every motherboard on the market. Twin M.2 slots both run at full speed, but neither has a heatsink, which is becoming more common on other 'boards as M.2 SSDs are prone to throttling under heat.

Unlike the Taichi, there's no integrated Wi-Fi or twin Ethernet, with a single Gigabit Ethernet connector in the rear I/O port. Next to these are just two USB 3.1 ports. There are, however, eight SATA 3 connections, a nice bump up from the

default. The audio solution is identical to the Taichi, using the same 'Sound Purity 4' solution.

Like all Z370 'boards, there's support for both SLI and CrossFire, though Nvidia is no longer promoting SLI, even though it's available. One great feature of this board is the UEFI BIOS; ASRock really knows how to make everything clean and legible. Having said that, most BIOSes are now very easy to use, especially compared to the Ryzen platform, which has dozens of cryptically named settings.

If you're looking for a very affordable 'board for your new 8th-gen CPU, then this will do the trick; just don't expect a huge bag of tricks.

Verdict

It's not as feature-rich as its cousin, but the Extreme 4 does pack in a few worthwhile goodies.



\$339 | WWW.ASROCK.COM

ASRock Z370 Taichi

Packing more features than most, at a price.

Amazingly, the price of this 'board has jumped \$50 over its RRP since it first came out, which is a first for motherboards. Luckily, it's got more features than most of the others, though it doesn't feel like the build quality is quite up to strength.

One of its highlights is the beautiful design with cog motif. It's a very individual looking 'board, though ASRock has toned down the RGB lighting.

There are three full-length PCIe x16 lanes, all of which are reinforced with steel, along with twin x1 lanes. Best of all, though, is the inclusion of three M.2 slots, more than any other 'board in the roundup. However, only two run at the full speed of PCIe 3.0 x4, with the third running at SATA 3 speeds. ASRock has also boosted the number of SATA 3 slots, increasing them to eight over the default six.

The heatsink system looks rather lacklustre

considering the 12-phase power system, and that's one of our issues with this 'board. It simply feels a little flimsy, possibly due to a thinner PCB than other 'boards or the lacking cooling. The same old Realtek ALC1220 audio codec used by most other manufacturers is in use here, but ASRock calls its version 'Purity Sound 4', making the usual claims about better amplifiers, capacitors and transistors. Again, nearly every company makes these claims.

It might be one of the more expensive boards, but you do get an extra M.2 slots and SATA 3 for the price – if only Z370 had more PCIe lanes to make full use of them.

Verdict

While we do have a couple of issues with this 'board, you do get a lot of bells and whistles for the price.





\$269 | WWW.ASUS.COM/AU

ASUS Prime Z370-A

Quite the looker.

This eye-catching 'board uses an all-black PCB with silver heatsinks and white I/O cover, putting it up there with the Taichi as one of the more attention grabbing units. It's also got a feature that seems to increasingly becoming commonplace on all motherboards – an I/O plate that is permanently mounted. Considering how painful it could sometimes be to line up the mobo with the removable I/O plate in days of past, this is a welcome addition.

There are a bunch of inputs; comprised of twin USB 3.1 Gen 2 (one type A, one type C), DisplayPort, DVI, HDMI, twin USB 2.0, Intel Ethernet, another two USB 3.1 Gen 1 and five 3.5mm minijacks. There's also a single S/PDIF if you're using an older amp.

This board has one more x1 lane than the rest, with four in total, along with three x16 lanes. M.2 support is disappointing, with two slots but one limited to

SATA 3 speeds. At least they have heatsinks, though, and you can even 3D print your own. Novice over-clockers will appreciate the '5-way optimisation feature', which automatically overclocks the CPU and controls things like power, fan speed and CPU settings. ASUS claims it should be possible to hit 5GHz with the top of the line i7 using this feature.

For once, we see a slightly different audio solution, using ASUS's S1220A 8-channel codec, which the company worked with Realtek to improve the ALC1220.

It's not quite as feature-rich as the other 'boards in this price range, so we have to give the likes of ASRock the nod instead.

Verdict

While nice to look at, and boasting some tempting features, it doesn't quite cut the mustard.



\$440 | WWW.ASUS.COM/AU

ASUS RoG Maximus X Hero

The priciest 'board here, but it's hard to say it's worth it.

This is the most expensive board in the roundup, yet it doesn't pack that many more features than the rest. At around \$440, we expected more, but it wasn't to be.

If there is one major difference, it's the audio codec. ASUS has worked with Realtek to refine the ALC1220, using an improved version known as the S1220. As for the rest of the package, it's business as usual. Six SATA 3 ports, twin M.2 and a single Gigabyte Ethernet port. At this price, we'd expect Wi-Fi but it isn't to be.

The layout is also the usual, with three 16x lanes and three 1x lanes, which is par for the course on much cheaper boards. ASUS is pushing the SLI capability of this motherboard, even though Nvidia is discouraging this.

Tweakers will appreciate the on-board buttons for clearing the CMOS and resetting the BIOS, while the range of I/O options

is substantial. There's HDMI 1.4b, Display Port 1.2, twin USB 2, four USB 3.1 Gen 1, twin USB 3.1 Gen 2, S/PDIF and five 3.5mm audio jacks.

One other area where this motherboard excels is its on board cooling solution. It's got arguably the best heatsinks of the lot, which does go some way to explaining the higher price tag. Oh, and of course, it's fully blinged out with RGB lights.

Yet, for the price, there's not much here that can't be found on boards \$100 cheaper. ASUS is using its RoG status to charge a premium without really delivering the goods. As such, we think this is a little overpriced for the product you're getting.

Verdict

Despite the premium RoG branding, this board doesn't offer a lot over cheaper competitors.





\$249 | WWW.AORUS.COM

Gigabyte Z370 Aorus Gaming 7

Welcome to your disco in a box.

Oh, dear... If you want your PC to look like a disco, this 'board has you covered.

Aorus has gone to town with the RGB lighting, with six different zones, each of which can be programmed to have a unique colour. It's called 'RGB Fusion' and should work with the majority of other company's RGB products so you can have one big flashy PC, mouse, keyboard and even monitor.

It's a standard ATX sized motherboard, and once again, we see three full-length x16 physical slots, all steel reinforced, with another three x1 slots. Each slot has a proprietary locking mechanism, which does actually hold the cards in more stably, while also being easier to unlock. The 'board also features plenty of buttons for things like rebooting, powering up and clearing the CMOS, which makes it a tweeker's delight, where the 'board won't be mounted in a case.

There are three M.2 slots, and everyone has a heatsink, which is a fantastic feature. SATA drops back to six, though, but twin Ethernet helps balance that out. Realtek's ALC1220 codec is wheeled out once again, this time called the 'Amp-up' audio solution, and it sounds identical to the other motherboards.

In terms of I/O options, there's DisplayPort, HDMI, USB 3.1 Type-C and twin USB 3.0 Type A on the I/O panel, which is a decent range. Overall, this board is excellent value... just like most of the other 'boards in the roundup, making it very hard to say definitively which one to buy.

Verdict

A flashy 'board that offers excellent value; check if its features meet your needs.



\$259 | WWW.AORUS.COM

Gigabyte Z370 Aorus Ultra Gaming

Hmm, this looks rather familiar.

One thing we haven't pointed out about the Z370 chipset is that it seems to be able to handle remarkable memory overlocks, and this 'board is no different. Most hit 4,000MHz, like this board, with a couple even claiming DDR-4,333MHz. You'll have to spend a bucket-load to get compatible memory for a minimal performance increase, though.

This is another motherboard that is festooned in bright lights, with a whopping eight different lighting zones capable of being programmed in one of 16.8 million colours.

Twin Ethernet ports are included on the rear, as well as USB 3.1 Gen 2 Type-C and Type-A, as well as HDMI, DisplayPort and an old fashioned PS/2 connector for old-school keyboards and mice. There's even five 3.5mm minijacks for really old sound systems.

In terms of physical layout, we have a pretty

standard design here, with three x16 and three x1 physical lanes.

The heatsinks aren't very impressive, but there's a plethora of fan headers for case fans, water pumps and radiators. Twin M.2 slots run at full speed, along with six SATA 3 ports. The BIOS is one of the most detailed in the roundup; Gigabyte is known for its overclocking prowess, hence the finer controls.

Once again, we're stuck in a dilemma. All of these motherboards are nearly identically priced, and identically specced. Whether or not you go for this one will probably come down to brand loyalty more than anything else.

Verdict

What separates this one from the crowd? Not much, but the crowd is a very nice one to be in.





\$299 | AU.MSI.COM

MSI Z370 Gaming Pro Carbon AC

Our pick of the litter.

The price on this motherboard has plummeted since its original release, down from an RRP of \$349. We're not sure why, as it's an excellent product. In fact, it's arguably our pick of the bunch.

This ATX 'board comes with three PCIe x16 lanes, along with another three x1, and two of the full length are steel reinforced. This stops GPUs from drooping, though 2018 will see many cases released with special vertical GPU mounts which also stops this issue.

Steel reinforcement has also been used on the memory slots, which is a bit of a gimmick; it's not as if a memory module weighs much. They're nice and far away from the CPU socket unlike some boards, allowing for an extra large cooler.

Twin M.2 slots, both running at PCIe 3.0 x4 are included, and they both come with heatsinks. MSI's 'M.2' Genie feature allows both M.2 drives to be set up

in RAID 0 mode quickly and easily, a feature that other motherboards lack. There are six SATA 3 ports, but the inclusion of Wi-Fi at this price point is a very nice surprise. As for inputs, we have one Gen2 Type-C, one Gen2 Type-A, and four Gen1, Type-A. There's also Display Port, HDMI, and five 3.5mm minijacks for sound.

MSI has gone to town with the lighting system, which it calls 'Mystic', while the easy-to-use BIOS can be configured to run in either beginner's or advanced mode, the same as other UEFI BIOSes these days.

Considering the inclusion of Wi-Fi at this price, and the excellent range of inputs, this is a fantastic basis for your 8th-gen CPU. Kudos to MSI.

Verdict

Our overall pick of the roundup, this 'board offers great usability and features at a fair price.



\$249 | AU.MSI.COM

MSI Z370 SLI Plus

Here comes another one, just like the other one.

By now, you've probably noticed a theme. All Z370 motherboards around the \$260 mark are pretty much identical. And the MSI Z370 SLI Plus is no exception. It's interesting that MSI has stuck 'SLI' in the product name, as Nvidia is no longer promoting SLI. We're guessing MSI's marketing team is simply leveraging the perception that SLI is faster.

Once again, we see lots of RGB lighting in the form of MSI's 'Mystic' system, which can be programmed via the easy-to-use desktop software. The layout of the board is identical to most of the others, with three x16 and three x1. Once more, we see twin M.2 slots, but there are no heatshields this time around, a surprising omission. Also, only one of these can handle the 2,280mm M.2 drive, with the other slot being shorter. Six SATA 3 slots is also standard, along with the ALC 1220 audio codec.

Same old, same old...

As for inputs, we have a single Gen 2 Type-A USB, single Gen 2 Type-C and four Gen 1 Type USB ports. There's also DVI-I, HDMI, a single Gigabit Ethernet and a quaint PS/2 input for older keyboards and mice.

It's really hard to differentiate in the motherboard market when all of the companies are targeting the same price point, and this 'board simply reinforces that notion.

Physically, they're all nearly identical, with buyer's choice coming down to aesthetics and brand loyalty. It's only when you spend a little more that you get a few extra features.

Verdict

The race is tight between these near-identical 'boards, so the choice is yours...



How to overclock non-K Intel CPUs

Phil Iwaniuk shows how you can still boost the speed of older Intel CPUs.

Once upon a time, ASRock did something wonderful for owners of Intel's non-K Skylake CPUs. For years previously, the benefit of buying a pricier K chip was that it was fully unlocked for overclocking, but in 2016, the rulebook was ripped up when a particular feature in ASRock's Z170A boards allowed base clock multiplier tweaking on those erstwhile locked K CPUs. Before long, MSI, ASUS, Gigabyte and the whole gang were offering the same BIOS feature, which disabled integrated graphics and turbo boosting in order to enable over-clocking. Intel was understandably less than pleased about this – the company's entire product hierarchy was suddenly jumbled up like a fallen Jenga tower – and just a couple of months afterward, overclocking features disappeared from Z170A boards.

In terms of outward appearances, the story pretty much ended there. Non-K chips returned to their previous station as staunchly locked cheaper chips, and the tech universe's natural order was restored. But those old BIOS files still exist, and are still available to download, so if you're currently running a non-K Skylake chip on a Z170A board, you can absolutely still make use of that old feature, and produce a significant performance boost for absolutely zero outlay and minimal time investment. Here's how.

ASUS Z170 Non-K OC Guide.

Motherboard	BIOS Download	Amazon
Maximus VIII Extreme	 ASUS Maximus VIII Extreme Non-K OC BIOS 7.95 MB 1962 downloads	Link
Maximus VIII Ranger	 ASUS Maximus VIII Ranger Non-K OC BIOS 8.03 MB 2903 downloads	Link
Maximus VIII Hero Alpha	 ASUS Maximus VIII Hero Alpha Non-K OC BIOS 7.95 MB 1216 downloads	Link
Maximus VIII Hero	 ASUS Maximus VIII Hero Non-K OC BIOS 8.04 MB 2991 downloads	Link
Maximus VIII Gene	 ASUS Maximus VIII Gene Non-K OC BIOS 7.90 MB 1994 downloads	Link
Maximus VIII Impact	 ASUS Maximus VIII Impact Non-K OC BIOS 7.89 MB 2094 downloads	Link
Z170 Pro Gaming	 ASUS Z170 Pro Gaming Non-K OC BIOS 6.50 MB 8867 downloads	Link

1 CHECK YOUR SYSTEM'S COMPATIBILITY

The first order of business is to figure out whether your CPU and motherboard can hack this, er, hack. Essentially, the full gamut of non-K Skylake CPUs are fair game for this, starting at the entry level with the Pentium G4400, and extending right the way up to the Core i7-6700. T chips are compatible, too. It's worth bearing in mind that the overclocking potential of a \$90 Pentium CPU is going to be much lower than a Core i7, and this BIOS hack isn't going to turn one into the other. It's free additional performance whatever the chip, though [Image A].

As for motherboards, check this handy web page for a full list of the ASUS, Asrock, MSI and Gigabyte

boards: <http://overclocking.guide/intel-skylake-non-k-overclocking-bios-list>. If it's a Z170A motherboard, it's extremely likely that you have the hardware to pull this off.

2 FIND THE OLD FILE

In order to enable overclocking, you need to flash your motherboard to an older BIOS that predates Intel clamping down on the practice. Doing so has pros and cons: Older firmware might produce hardware conflicts or cause any problems your motherboard model had at launch to re-emerge, because you're effectively rolling back all manufacturer support to late 2016. In our experience, though, this is unlikely. If the worst comes to the worst, and you have a USB port that Windows keeps discovering and



forgetting every 10 seconds after flashing your BIOS, you can always install the newer version again to remove the issue. To start the ball rolling, head to the site we've linked to in step one. You'll see a list of motherboards, each with a BIOS file to download. Simply locate your own motherboard model and download the BIOS file [Image B].

FLASH YOUR MOBO'S BIOS

There was a time when flashing your BIOS was a scary process. One power outage or erroneously placed file, and it was goodnight Irene for your motherboard. These UEFI BIOS-enabled days, it's a reasonably simple process, so there's no need to read your hardware its rights, or call in any precautionary priests. Simply copy the BIOS file you downloaded in step two to a USB drive – the root directory is fine. Now reboot your PC, and press Del when the prompt appears. Welcome to the BIOS. Here, you'll see a flash utility within the main options that enables you to select a new – or old – BIOS file, and install it. Simple.

ENABLE THE MAGIC SETTINGS

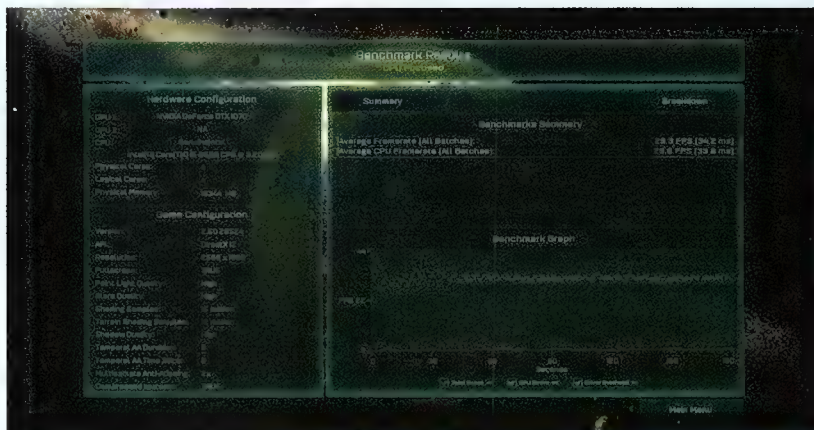
After the faintly terrifying BIOS installation bar has been filled and the machine restarts, re-enter the BIOS and head to the overclocking options. The exact options vary depending on your motherboard, but the important one is 'SKY OC'. This is the feature that disables turbo and integrated graphics, and allows big BCLK overclocking. On MSI boards, you need to enable 'Expert mode' in the overclocking screen first, then enable SKY OC. Your non-K chip is now ready to be buffed up [Image C].

SET YOUR INITIAL OVERCLOCK

Any BCLK value above 100 boosts the CPU's base clock – our Core i5-6500 can handle 135 with liquid cooling, for reference, but we recommend starting with 110, and increasing by 10 after every stable test. Increasing the BCLK also increases RAM frequency automatically, so you need to modify that RAM value to speeds you know

Off the clock

How much extra performance can you squeeze out of a non-K chip? We'll use a Core i5-6500, and run some benchmarks to demonstrate. It's overclocked by 1.1GHz, from 3.2GHz to 4.3GHz, while the RAM is at just over 3,200MHz. First up is Heaven 4.0, a GPU-intensive app that doesn't show much improvement for that extra 1.1GHz: 50.2fps at stock speeds, and 50.3fps overclocked. Heartbreaking. Things get more encouraging when running CPU-intensive RTS Ashes of the Singularity: Escalation, though: 25.8fps at stock, 29.3fps overclocked. Cinebench R15 sees a jump from 524 to 727, while Middle-Earth: Shadow of War jumps from 52fps to 62fps. Result!



your sticks can handle next. When you're setting the first stable overclock, don't go more than 100MHz above your RAM's advertised frequency. Our DDR4 modules can hack up to 3,200MHz, which allows plenty of headroom. The only other value to worry about is core clock voltage. You can crank this up to 1.35V without frying anything, and may be able to lower it again after setting stable values elsewhere.

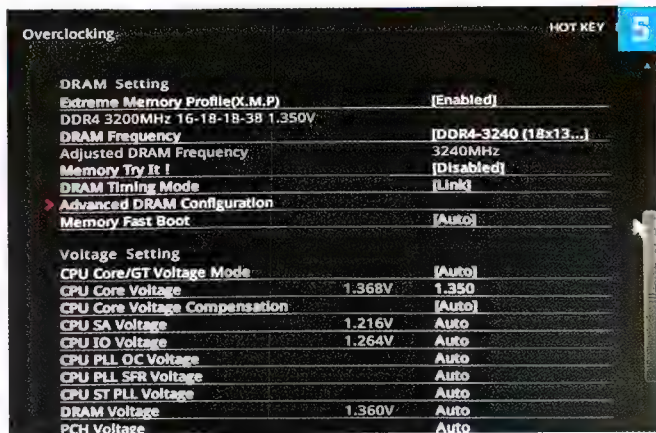
TEST IT OUT

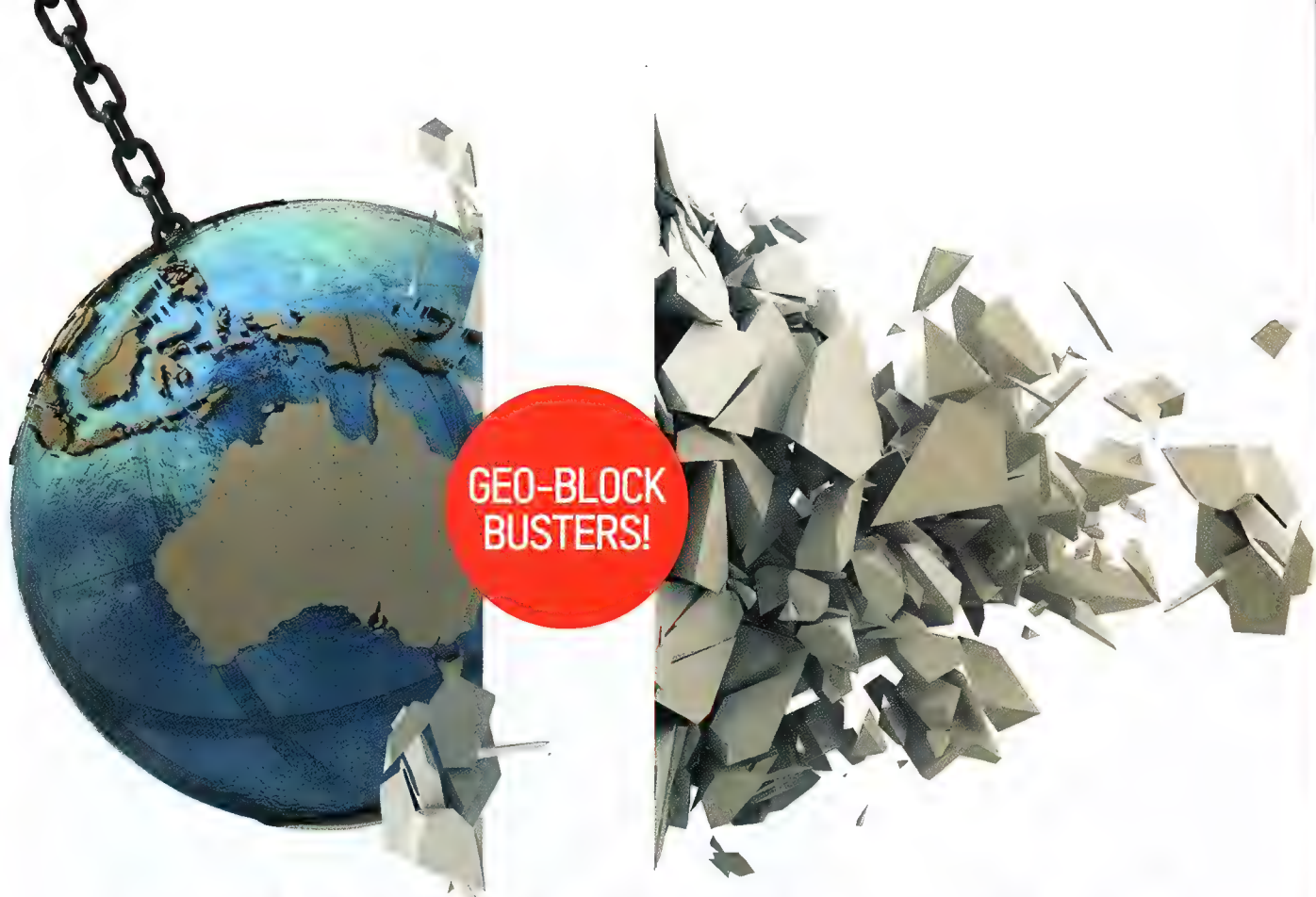
If you set and saved your overclocked values, and your machine booted to Windows, that's a good sign. It doesn't mean you've achieved a stable overclock, though. You need to stress test your machine by running a synthetic benchmark in order to figure out whether your values are stable, so load up Cinebench R15 and run 5-10 CPU tests. After that workout,

you'll either see a blue screen or know your numbers are solid [Image D].

TWEAK THE NUMBERS

So you've got a stable performance boost for free, on a chip that was never intended to provide it. Hooray! What's next? Trying to squeeze still more performance out of it [Image E]. Obviously. Steady incremental increases of the BCLK value back in the BIOS is the next item on the agenda, then, although we can't stress enough that going beyond 1.35V is a risk/reward equation that simply isn't worth it. Limit yourself to that voltage, and then see what your CPU and RAM can handle by repeating step six. Eventually, you'll hit the ceiling and, at that point, you can enjoy the satisfaction of having performed a hardware upgrade for absolutely nothing. ■





UNRESTRICTED ACCESS

Nathan Taylor's **comprehensive guide to busting through internet blocks and dodging region restrictions.**

So you like your internet unfiltered, with access to the full array of services and sites without any censors or geoblocks getting in the way. You'd like to be able to watch the BBC online, access Hulu or Netflix US and visit sites that would otherwise be restricted. This is the guide for you.

We're going to be looking at various ways you can get around different types of restrictions on all your devices. In particular, we'll walk through the four most common ways you can access an unrestricted internet.

FOUR WAYS TO GET AROUND BLOCKS

Before we get into specific techniques, we should talk at a high level about these different solutions, and what they're good (and not so good) for.

1 DNS

The domain name service (DNS) is like the White Pages of the internet. It takes human-readable URLs like **techlife.net** and translates them into IP addresses.

As noted in the sidebar 'How the new site restrictions are being implemented', ISPs have begun using the trick on modifying their DNS servers so that certain sites can't be

looked up – kind of like ripping their entries out of the White Pages. The sites are still there, and still accessible, but your computer won't be able to look up their IP address.

Well, it won't be able to unless you make a single, simple modification to your internet settings. If your ISP's directory has been modified, then just use somebody else's. For most people, that 'somebody else' is Google, which runs its own (very fast) DNS servers. The address of that server is 8.8.8.8 (8.8.4.4 for the secondary) and you just need to modify your DNS server address to that to get unrestricted access.

In lieu of Google, some people prefer to use OpenDNS (**opendns.com**) at 208.67.222.222/208.67.220.220.

2 VPN

VPN services are a catch-all solution for hiding your activity from snooping ISPs and for hiding your country of origin from media services.

When you connect to a VPN, an encrypted tunnel is created between you and a server run by the VPN provider. All your data is sent along that tunnel, and the VPN provider then relays it to its destination. This has two effects: your ISP can only see that you're communicating with the VPN provider and no one else; and all your

traffic appears to come from the VPN server, so that sites you visit will think you're visiting from the same country that the VPN server is in. If the VPN server is in the US, your traffic appears to come from the US, bypassing geoblocks.

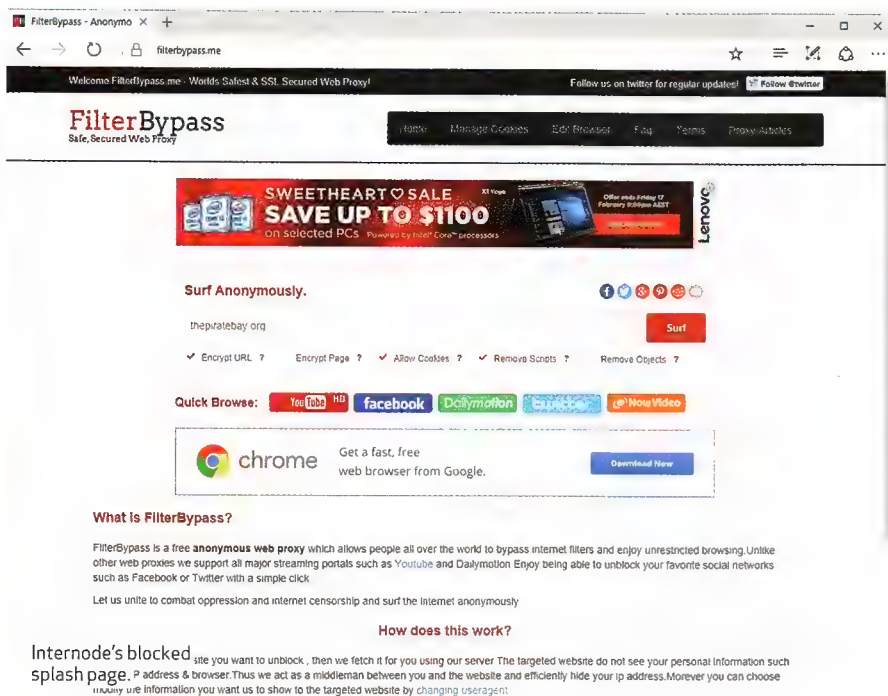
For most people, VPNs serve as the all-in-one solution for getting around site restrictions.

3 TOR

Tor, formerly known as The Onion Router, is an anonymising network that sits on top of the regular internet. Like a VPN, it allows you to route through other parties, obscuring both your source IP address from sites you visit and your destination IP address from your ISP.

Unlike a VPN, however, you're not routing through a fixed server – you're routing through other Tor users. Your traffic will bounce between at least three other Tor users on its way to its destination (the traffic is encrypted, so they can't read it), completely obscuring its origin.

Tor represents pretty much the ultimate in internet freedom. It works around every restriction and can unlock any site, and there's nobody that can monitor your activity online. There are even Tor-specific sites called 'Tor hidden services', accessible only



to Tor users. Although it's great at working around content blocks, it's not great for media. All that data bouncing around results in lowest-common-denominator speeds, so you're not going to be able to stream Netflix with it, for example.

4 PROXY A proxy server works much like a VPN, allowing you to route through an intermediary (the proxy), which obscures your destination from your ISP/network provider (they can only see you connecting with the proxy server), as well as your country of origin from the destination website. They're most commonly used as a simple and easy way to get around work and school website restrictions, but can also be used to fool ISP blocks. In general, there are two types of proxies that you might use. The most common type of proxy is the web-based proxy. These are simply web pages that you visit, give them a URL, and they will relay the page to you (usually in a browser frame). People often use Google Translate as a web-based proxy, but if you want a dedicated proxy page

you can try www.filterbypass.me, newipnow.com and proxy.org, the last of which has a list of web proxy services. Alternatively, there are the true HTTP/SOCKS proxies. This is where you go into your internet settings and modify the proxy settings so that all your browser traffic flows through the proxy. You can find a list of some of the available free and open servers at www.xroxy.com/proxylist.htm, though these tend to be very, very slow. There are also commercial anonymous proxy services available,

ACCESS TO WEBSITE DISABLED

You have attempted to obtain access to a particular website. This page notifies you that access to that website has been disabled because the Federal Court of Australia has determined that the website infringes, or facilitates the infringement of, copyright.

Filter Bypass,
a web-based proxy
service.



sometimes in conjunction with VPN services and sometime standalone (such as TorGuard's Anonymous Proxy). Only the commercial ones really stand a chance at being fast enough for media streaming.

How Australian ISPs block websites

When the Copyright Amendment (Online Infringement) Bill was passed in 2015, it opened the door for copyright holders to petition the Federal Government to have infringing websites blocked. And that has happened: a parcel of sites including The Pirate Bay, Torrentz, TorrentHound, IsoHunt, SolarMovie, Putlocker, Watch TV Series, Vumoo and a number of others have been added to the ban list, with ISPs now being required by law to block them.

The Bill, however, did not specify how the ISPs were to implement the blocks. Right now, most (including Telstra, Optus and TPG) are using DNS poisoning, modifying their DNS servers so that, when your browser requests the IP address of one of those sites, it is instead given the IP address of a "site blocked" splash page. That means, to defeat the blocks, you only need to change your DNS server address — one of the easiest fixes available.

WHAT EACH SOLUTION IS GOOD FOR (AT A GLANCE)

	CAN IT DEFEAT ISP SITE BLOCKS?	CAN IT DEFEAT GEOBLOCKS?	CAN IT DEFEAT LOCAL BLOCKS (IN SCHOOLS AND WORKPLACES, FOR EXAMPLE)?
USING A PUBLIC DNS SERVICE SUCH AS GOOGLE DNS	YES	NO	NOT LIKELY.
USING A VPN	YES	YES	YES
USING TOR	YES	YES, BUT PROBABLY TOO SLOW FOR STREAMING MEDIA	YES
USING A WEB-BASED PROXY	YES	YES (BUT MOST PUBLIC FREE ONES WILL BE TOO SLOW FOR STREAMING MEDIA)	YES
USING AN HTTP/SOCKS PROXY	YES	YES (BUT MOST PUBLIC FREE ONES WILL BE TOO SLOW FOR STREAMING MEDIA)	YES



» unrestricted access

How to bypass geoblocks on your PC

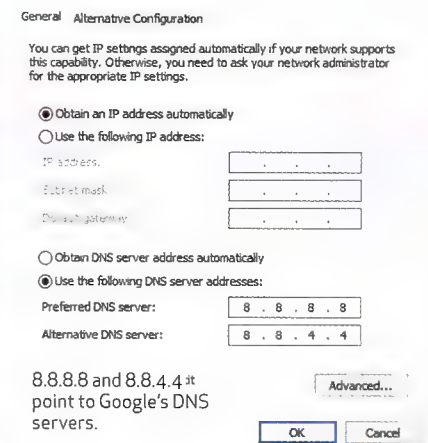
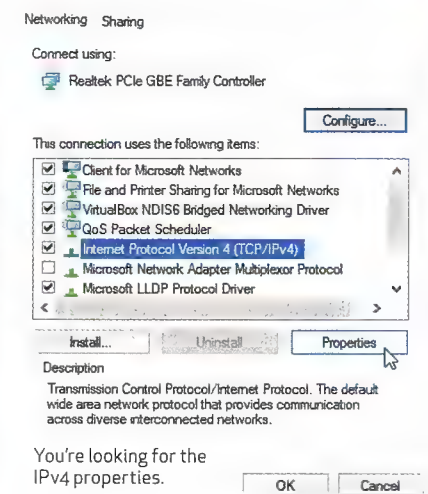
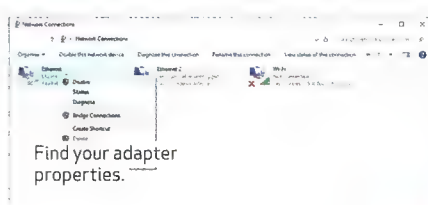
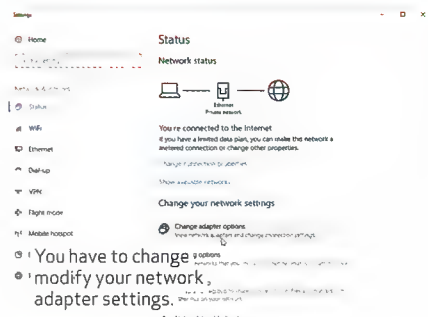
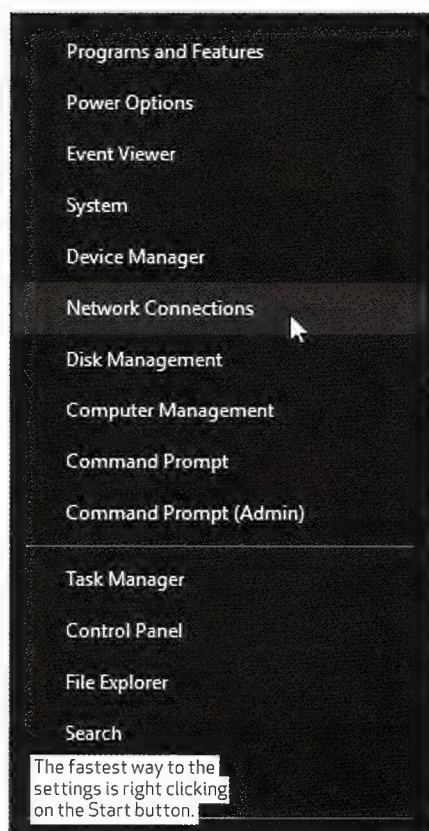
PC and Macs naturally give you the most flexibility when it comes to bypassing blockades. All the options are available to you.

1 CHANGING YOUR PC'S DNS

If you'd just like to be able to access the sites that might be restricted by your ISP, the simplest thing to do is change your PC's DNS server. All you need to do is find your computer's DNS settings and enter a new DNS number.

On Windows, just follow these steps:

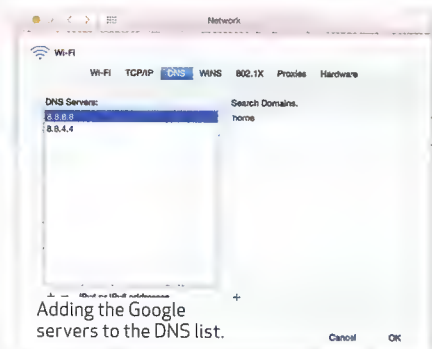
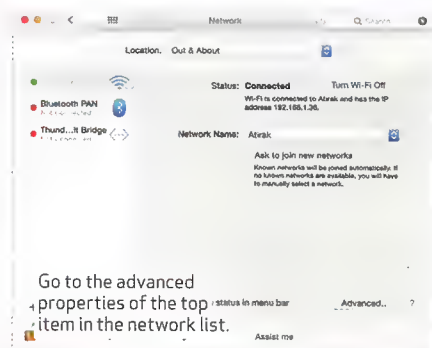
- Right click on the Start button and select 'Network Connections'.
- Click on 'Change Adapter Options'.
- Right click on your network adapter (whichever one you're currently using, Ethernet or wireless) and select properties.
- Find 'Internet Protocol Version 4' (TCP/IPv4) in the list and left click on it to select it. Then click Properties.
- Switch the radio button to 'Use the following DNS server addresses:' and enter 8.8.8.8 in the preferred DNS server field and 8.8.4.4 in the alternative DNS server field. Click OK and you're done.



On Mac OSX, the process is thus:

- Click on the Apple button and select System Preferences.
- Click on Network.
- Click on the first item on the list (which is the network you're currently connect to) to select it, then click on Advanced.
- Click on the DNS tab. Then click on the '+' button under DNS servers to add a server.
- Add 8.8.8.8 and then add 8.8.4.4. Click OK.

Once applied, you should now have access to any sites blocked by your ISP.



privateinternetaccess vpn settings

Username

Password

[Forgot password?](#)

☐ Start application at login

☒ Auto-connect on launch

☒ Show desktop notifications

Use the app provided with the VPN service. Just enter your username and select a country.

[Advanced](#)

US California
auto
US California
US East
US Midwest
US Chicago

2 USING A VPN ON A PC

Although Windows and Mac both have VPN services built in, as a rule it's far, far easier just to download the app supplied by your VPN service provider. Just head to its website and look for the downloads page.

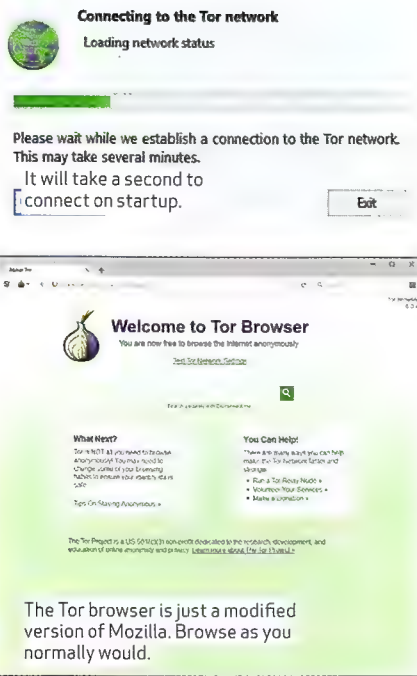
Each app is a little different, but in general, you have to enter your VPN account username and password and select a server. The location of the server will determine where you will appear to be coming from when you visit a site. To access the BBC, for example, you would select a UK server. If all you want is to bypass your ISP's block or maybe just general BitTorrenting, you can choose an Australian server for maximum speed.

3 USING TOR ON YOUR PC

Lots of people use Tor as an all-round privacy shield. Even a VPN doesn't provide complete anonymity, since the VPN provider still knows what you're up to. But Tor provides complete privacy, bypassing nearly any kind of block.

These days, it's remarkably easy to use, as well. You just download the Tor browser and most of the technical stuff happens in the background.

- Head to www.torproject.org. Click on the link to Tor Browser, then download it for your language and platform.
- The Tor browser is simply a modified version of Mozilla, tuned for maximum security and using the Tor network in the background. When you've downloaded and installed it, start it up.
- You'll see an initial connection box. It shouldn't take long to connect.
- Once you're connected, the Tor main page will appear. You can now just browse the internet as if you were using any other browser.
- As a check, you can head to www.iplocation.net, which will tell you your current apparent IP address



and geolocation. It should be different from your normal address, and the geolocation will show the location of whichever Tor exit node you're using (which could be anywhere — it's more or less random).

If you want to use Tor to appear to be from a specific country, then you'll have to edit the torrc file, a configuration file that's kept in the directory where your Tor browser application is installed. In Windows, you can generally find the file in 'This PC > Desktop > Tor Browser > Browser > TorBrowser > Data > Tor'.

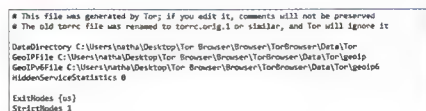
Open the torrc file up in Notepad. Then add two lines to the end of it:
`ExitNodes {countrycode}`
`StrictNodes 1`

Where countrycode is the two letter code representing the country you wish to appear to be from. You would use {us} for the United States; {uk} for Britain and {au} for Australia, for example. A full list of country codes can be found on the Tor Project site.

Save the file (remember it does not have a .txt extension) and next time you start the Tor browser you should appear to be from that country to sites you visit.

4 USING A PROXY ON YOUR PC

Using a web-based proxy to bypass site blocks is extremely easy.



Selecting a specific country with Tor requires you edit the torrc file in a text editor like Notepad. This example has us appearing to be from the US.



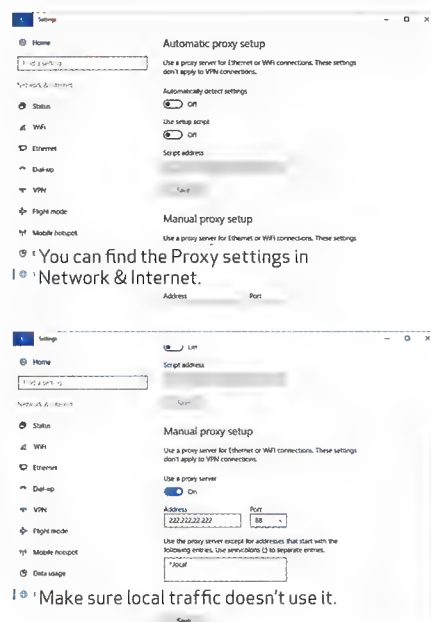
Just go to the website of your preferred web based proxy and type or paste the URL of the site you'd like to see in the URL field.

For example, if you wanted to visit The Pirate Bay, but your ISP is blocking it, you can go to filterbypass.me and type "thepiratebay.org" into the URL field. The Pirate Bay site will then load into a frame below the web proxy's header box.

Setting up an HTTP or SOCKS proxy is a little more complicated. If you set one of these up, all your web traffic will be routed through the proxy, not just one site. You'll need the proxy server IP address and port number to make it work.

In Windows 10, follow these steps:

- Click on 'Settings > Network & Internet'.
- On the left-hand panel, the bottom entry is Proxy. Click on it.
- Under 'Manual Proxy setup', change the switch to 'Use a proxy server'. ('Automatic proxy setup' is typically used when you're supplied with an automatic setup script, which happens mostly in corporate environments).
- Enter the proxy IP address and port number in the fields.
- Check the box for 'Don't use the proxy server for local (intranet) addresses'.
- Click Save.





» unrestricted access

Bypassing blocks on other devices

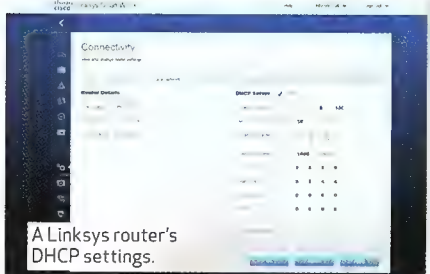
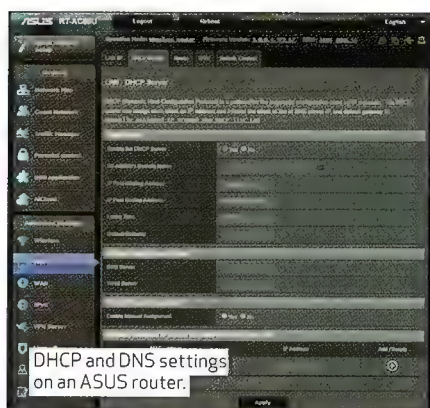
While it's easiest to bypass blocks on a PC, you also have options on other devices as well.

On mobiles, you actually have access to all the same tools as on PC. You can modify your network DNS settings just like on a desktop. You can download your VPN provider's app. You can use proxies in your browser, as well. On Android, you even can install an app called Orfox to access the Tor network.

Other devices like smart TVs and consoles can be trickier. Your best option may be to not try to modify the device at all – the best tool you have in this case is your router. With a few simple modifications, you can make it so that every device on your network will use Google DNS automatically. That way a single modification covers every device.

CHANGING YOUR ROUTER'S DNS

Configuring DNS services on your router has a major advantage – it instantly covers all your devices. Any device that connects to your router with auto-configuration (aka DHCP) switched on will have the benefit of using your router's DNS configuration.



Now, normally your router will use the DNS server address provided to it by your ISP when you connect to the internet. But this doesn't have to be the case. You can change your router's DNS so that the DNS server address it uses and hands out to your devices is one you specify.

Unfortunately, the exact way of doing this varies from router to router. Generally, you're looking for the DHCP settings or DNS settings.

- On most ASUS routers, click on 'LAN > DHCP Server' and look for the DNS server field.
- On D-Link, click on 'Setup > Manual Internet Connection Setup' and change only the DNS server fields under 'Dynamic IP'.
- On DrayTek, you'll find it under 'LAN > General Setup'.
- On Linksys routers, they're usually found under 'Connectivity > Local Network', under DHCP server.
- On Netgear, click on Basic Settings, then 'Use these DNS servers'.

- On TP-Link, click on DHCP in the left hand panel, then on DHCP Settings.

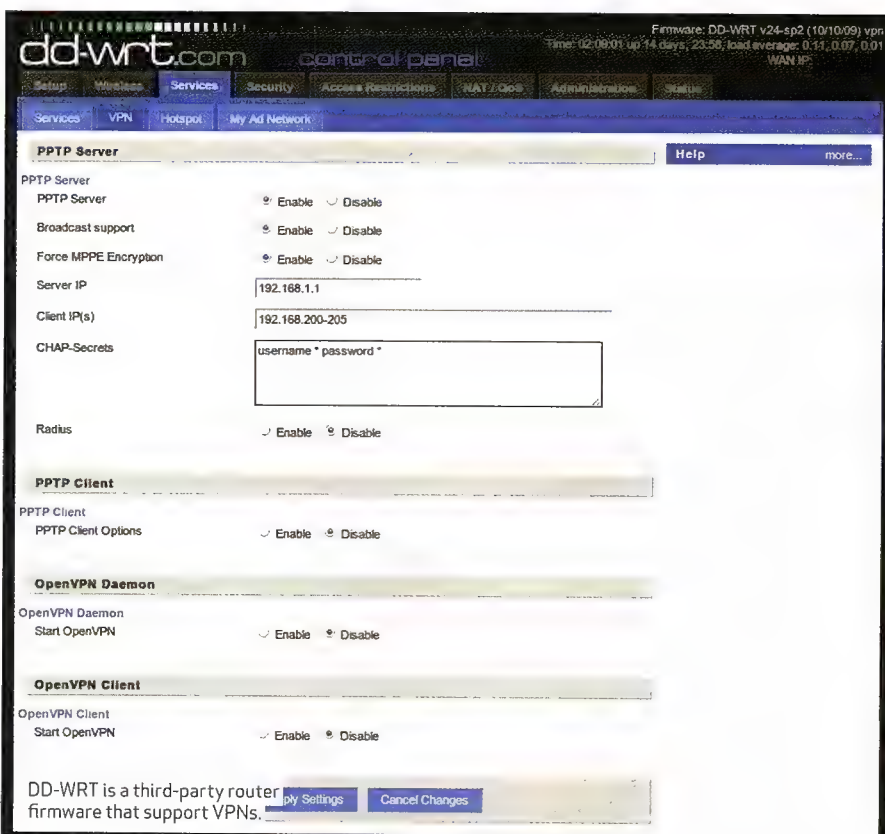
In the DNS fields, enter the numbers 8.8.8.8 (primary) and 8.8.4.4 (secondary) if you're going to be using Google's DNS servers. Then save the settings.

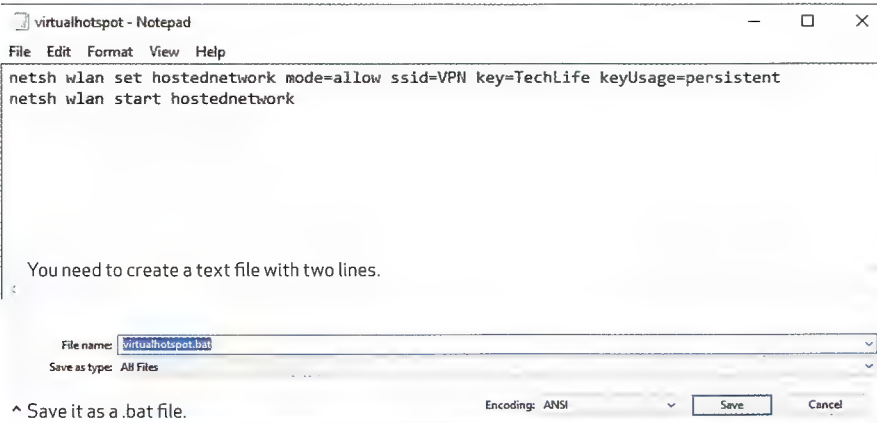
Now when a device connects to the network, it will be assigned those DNS server addresses, bypassing your ISP's DNS and its site blocks.

USING A VPN ON YOUR ROUTER

It's also possible to set up a router so that all traffic from your network is routed over a VPN. That means even your smart devices like television sets can use the VPN service to bypass geoblocks.

This is not for the faint of heart, however, and you need a special kind of router to do it. Your router must support VPN services. Most ASUS routers do, as do most DrayTeks.





But the majority of other consumer routers do not. On many such routers, however, you can install a third-party firmware like dd-wrt (dd-wrt.com). If you want to install DD-WRT, visit the site and see if your router model is supported, and then follow the installation instructions for that router model very carefully.

Unfortunately, there's no universal guide we can provide for setting up a VPN on a router. Every VPN service provider has a different configuration. Your best bet is to visit the website of your VPN service provider and look for the guide for setting it up on your router. Most of the major providers have guides for DD-WRT.

Even then, you do have limitations. It's not easy to switch between VPN locations, for example — you have to manually log into your router and change the VPN server address. On the other hand, it does allow devices that normally couldn't use the VPN to use it.

SHARING YOUR PC'S VPN

There's also another way to extend a VPN service to devices that might not have VPN clients, such as smart TVs and consoles. If you have a VPN set up on your PC, it's possible to share it with those devices.

You will need a Windows PC that supports Wi-Fi. If that's the case, you can actually create a hotspot on your PC that the device can connect to.

Then you share the VPN connection with them.

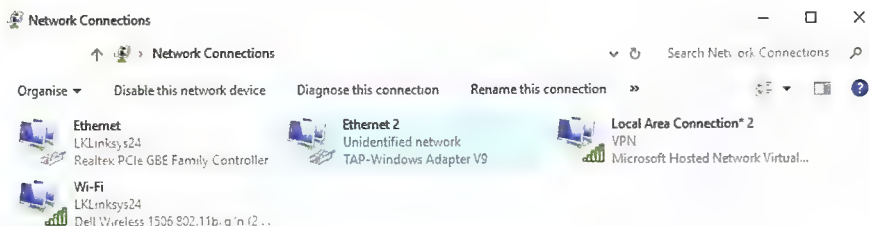
Follow these steps:

- First, we turn your PC into a Wi-Fi hotspot. On your Windows PC, open Notepad.
- Type the following two lines into Notepad, replacing <SSID> with the name you want your virtual hotspot to have (eg. VPN) and <Password> with the password you want to use:

```
netsh wlan set hostednetwork
mode=allow ssid=<SSID>
key=<Password>
keyUsage=persistent
```

```
netsh wlan start
hostednetwork
```

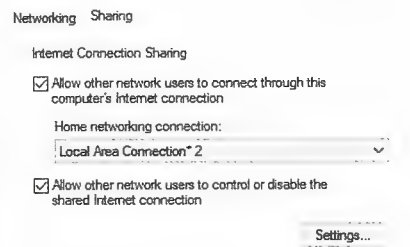
- Save the file as 'virtualhotspot.bat'. Make sure it has the .bat extension, rather than .txt.
- Now, in File Explorer, right click on virtualhotspot.bat, and select 'Run as administrator'. You may get a prompt asking if you want to allow it (say yes). Once you've done that, you should be good — you've created a virtual hotspot on your PC.
- Now to share your VPN connection. When you installed the VPN app from your provider, it should have created a new networking adapter driver on your PC. We're going to share that. Right click on the Start button and select Network Connections. Then select 'Change Adapter Options'.



- You should see your regular wireless and wired connections. You should also see the new hotspot you've created in steps 1–4. And finally, there should be a TAP driver, created by the VPN application. Find that, right click on it and select Properties.
- In the Properties window, click on the Sharing tab. Check the box to Allow other users to connect through this computer's internet connection.
- Under 'Home networking connection', select the network device that corresponds to the virtual Wi-Fi device you've just created. Most likely, it will be Wireless Network Connection 2 or Local Area Connection 2. Click OK.
- You've now shared your VPN connection with all devices that connect to the Wi-Fi hotspot you created in steps 1–4. All that's left to do now is connect to it.
- On your smart device, go to the Wi-Fi settings. Find the network name that you gave your Wi-Fi hotspot in Step 2 and connect to it. Now, any data sent to and from the device should go through the VPN, bypassing geoblocks just like your PC does. If your device has a browser, you can check that it's working just by going to www.iplocation.net and seeing where it says you are.

That should be it: you've now shared your PC's VPN connection, and its ability to work around censorship and geoblocks, with any device that connects to the virtual hotspot. Note that when your PC reboots, this virtual hotspot will disappear, but you can start it up again by right clicking on the virtualhotspot.bat file and selecting 'Run as administrator'.

And that should be everything — every device in your home should now be able to dodge geoblocks, avoid site censorship and generally access all that the internet has to offer. Enjoy! ■



Enable Sharing for your VPN adapter.





» the best vpns for aussies compared

The best VPNs for Aussies compared

Nathan Taylor finds out how the major VPN services currently stack up and discovers which are worth your money.

Whether you want to work around online censorship and geoblocks, or just want to maximise your security and privacy, a VPN service can get the job done. The right service can give you access to media you can't get Down Under, including the international libraries of Netflix, as well as protect your online activity from hackers and government snoops.

Below, we've looked at some of the top VPN services available today. We've tried to focus on the largest and those that support Netflix in some fashion, though there are a number that we felt were noteworthy enough to include even though they can't access Netflix. We set up and tested them all, but we should make the very important note that we're only talking about our experience with the VPN. Speeds, for example, will vary from server to server and time to time — so you may find that, in some cases, you get notably better or worse performance than we did.

TESTING VPNS

The easiest and most common way to test a VPN service is to head to speedtest.net and run the default test when you're connected.

Where we referenced speeds in the reviews, this is exactly what we've done — though, as noted above, speeds can vary wildly from time to time and server to server.

Netfixing and Huluing

One of the things that many users want out of a VPN is the ability to watch content that's normally restricted by geography.

Services like Netflix, Hulu and the BBC use geolocation to restrict content based on country, and a VPN can potentially trick those services into thinking you're in a different country and are, thus, authorised to access that country's library. With Netflix, you don't even need a separate account for the US — one Netflix account is good the world over.

However, both Netflix and Hulu now block VPNs and proxies from accessing their service. This has turned into a game of cat and mouse with VPN providers. Netflix blocks some VPN IP addresses, so the VPN provider switches them up. Many VPN providers have given up the game, but some still play it, including most of the providers here.

Even if a VPN provider does still give you access to Netflix and Hulu, you probably won't just be able to connect to any server and have it 'just work'. Typically, what you have to do is contact customer support and ask which servers still support Netflix.



US\$13 PER MONTH, US\$100 FOR A FULL YEAR
BUFFERED.COM

Countries served: 37; Netflix support: No;
Clients: Windows, MacOS;
Simultaneous connections: 5

Buffered Brought down by hubris.

Buffered once marketed itself as a perfect VPN for accessing Netflix's international library, and even went so far as brazenly putting a Netflix logo on its web page. Apparently, that got Netflix's attention, and at the time of writing this article, Netflix is blocked on Buffered, although the VPN provider claimed to be working on a solution. Still, it's a fast VPN for other services. Running the speedtest.net benchmark indicated a speed of 18.3Mbps from that server, and impressive speed nearly rivaling that of ExpressVPN and NordVPN.

The Windows client is very simple — there's not much to it other than a basic country selector. We do like that it gives you a live speed and data indicator, as well as a ping indicator for the different servers (though it would have been nice to see current load as well). Sadly, there are no mobile clients for Buffered, which is a major issue. You have to configure mobile clients manually using the OpenVPN app, which means no easy server switching.

Verdict

It's fast, but the lack of mobile clients is a problem and it no longer supports Netflix. There are better options.





US\$12 PER MONTH, US\$66 FOR A FULL YEAR
WWW.CYBERGHOSTVPN.COM
 Countries served: 51; Netflix support: Yes;
 Clients: Windows, MacOS, Android, iOS, Linux;
 Simultaneous connections: 5

CyberGhost

A new contender.

Once just an OK service with limited support for Netflix, CyberGhost now has support for the streaming network baked right in and it works really well.

You don't have to contact support to find the 'secret' Netflix capable server, either. There's an option right in the VPN app in the Unblock Streaming menu to choose a server that supports Netflix US (there are also specific options for the BBC and other services, as well). Select it, and it will connect you to the right server. It worked perfectly for us, on the first try, and with fast enough speeds to support smooth streaming in HD.

It also has ad-blocking built in. It has a kill switch and app protection, as well as SOCKS proxy support, so you can effectively choose which apps use the VPN and which do not. With really solid speeds to top it all off (13.4Mbps to the US when we tested it), and servers listed by load and speed, we can away really impressed with CyberGhost. It's a great choice right now and highly recommended.

Verdict

A ton of privacy options and native support for Netflix. An excellent user-friendly choice.



US\$13 PER MONTH, US\$100 FOR A FULL YEAR
WWW.EXPRESSVPN.COM
 Countries served: 94; Netflix support: Yes; Clients:
 Windows, MacOS, Android, iOS, Linux; Simultaneous
 connections: 3

ExpressVPN

There's nobody faster.

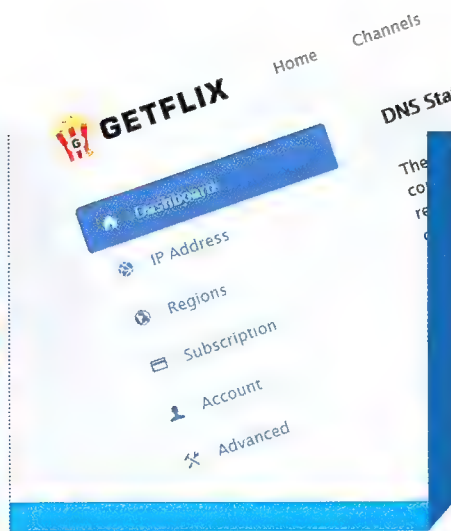
One of the world's largest VPN providers, and also one of the most expensive, ExpressVPN justifies its cost with both unrivalled reach and unbeatable speeds. It has servers in 94 countries and in our testing essentially maxed out our 30Mbps connection when using the recommended server in both Australia and the US.

The app is as simple as they get. There are almost no options apart from choosing your server, and the service doesn't have fancy features like kill switches and ad blockers.

You can connect up to three devices at once on a single account. It also offers 24/7 support — which we found both responsive and helpful — and the ability to pay anonymously through Bitcoin and Bitpay. ExpressVPN is also one of the services that still supports Netflix in the US, the UK and several other countries. You will have to chat to a customer service operator and ask which server to connect to, but we found it worked perfectly, capable of high-def Netflix US and Hulu.

Verdict

It's expensive, but it's super fast and supports Netflix. Highly recommended.



US\$5 PER MONTH, US\$40 FOR A FULL YEAR
WWW.GETFLIX.COM.AU
 Countries served: 38; Netflix support: No; Clients:
 None; Simultaneous connections: Unknown

Getflix

Smart DNS provider turned VPN provider.

Getflix began life as a Smart DNS service, and while that remains its primary offering, it now also offers VPN services to all subscribers. The Smart DNS service allows you to access most of the world's leading streaming services just by changing the DNS server address on your home devices. However, Netflix, once a staple of the service (and its namesake), is no longer listed as supported and did not work when we tested it.

While its Smart DNS services are up to scratch, however, its VPN services are not. They are fast enough — 9.3Mbps to Los Angeles when we tested it — but there is no client for it at all. You have to use the VPN services built into Windows/Android/iOS or use the third-party OpenVPN client. If you even want to change location, you have to go to Getflix's website to look up server addresses, then manually change it in the VPN configuration. It's not good, and is probably best seen as a free bonus to the Smart DNS service rather than a viable VPN service in its own right.

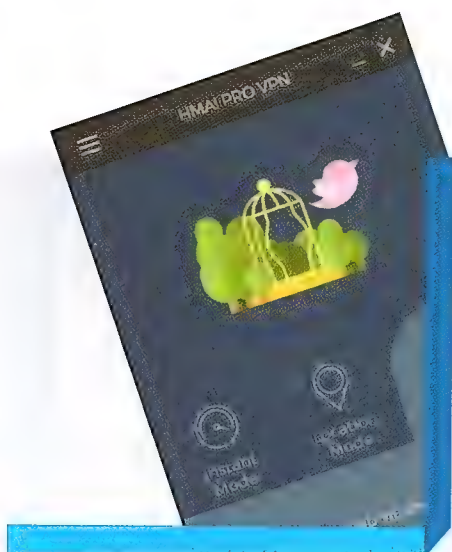
Verdict

As a Smart DNS service, it's great. As a VPN service, not so much — although it is very affordable.





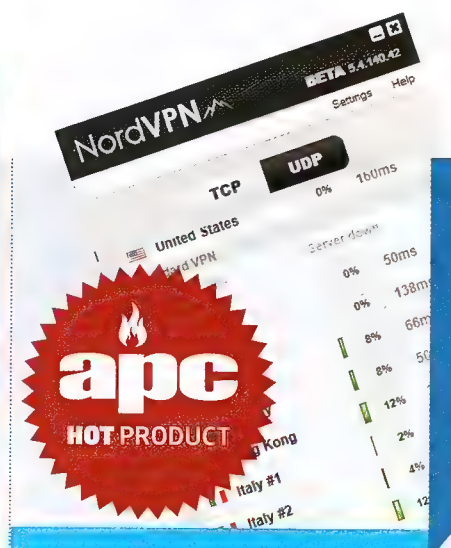
» the best vpns for aussies compared



AU\$17 PER MONTH, AU\$111 FOR A FULL YEAR | WWW.HIDEMYASS.COM
Countries served: 190; Netflix support: Yes;
Clients: Windows, MacOS, Android, iOS, Linux;
Simultaneous connections: 5



US\$10 PER MONTH, US\$78 FOR A FULL YEAR WWW.IPVANISH.COM
Countries served: 60; Netflix support: No;
Clients: Windows, MacOS, Android, iOS, Chrome;
Simultaneous connections: 5



US\$12 PER MONTH, US\$69 FOR A FULL YEAR WWW.NORDVPN.COM
Countries served: 58; Netflix support: Yes;
Clients: Windows, MacOS, Android, iOS;
Simultaneous connections: 6

Hide My Ass! The comeback kid?

One of the oldest VPN providers around, some poor performances in previous reviews and lack of support for Netflix had dropped Hide My Ass! off our radar and out of our reviews. Last year, however, Hide My Ass! reversed course on Netflix and started offering a server specifically for people that wanted to watch Netflix. So we thought we'd give it another shot.

The good news is that we had no problems accessing Netflix and Hulu in either a browser or the dedicated apps. However, the server was so congested that the streams were almost unwatchable. It wasn't just the Netflix server that had trouble. Performance across the board was spotty at best, and we couldn't find a US server that would connect at more than 5Mbps, and many operated at well under 1Mbps when we tested it.

It has a neat, well-designed PC client as well as mobile clients, but those weren't enough to make up for its shortcomings. For now, Hide My Ass! remains on our Nope list.

Verdict

Netflix is back on the menu, but the performance is still a problem.



IPVanish Top performer.

One of the oldest hands in the VPN business, IPVanish comes with an attractive and well-designed app for both Windows and Mobile and a full feature set. However, it has decided to give up the fight against Netflix and no longer offers support for working around Netflix's geoblocks. There's still an awful lot to recommend about IPVanish — we particularly like its ability to arrange servers by ping or bandwidth. That makes it much easier to select a fast server for you without having to go through the usual server hopscotch. Picking the fastest server in both Australia and the US produced some very impressive speedtest.net results when we tested it. Our 30Mbps connection was essentially maxed by the VPN on both servers, which is very impressive. IPVanish doesn't throttle BitTorrent, either. IPVanish ticks many of our other boxes as well: no logging, PPTP and OpenVPN support, 24/7 customer support, money-back guarantee. Indeed, except for its lack of Netflix support, IPVanish is great pick.

Verdict

Great performance and ticks all the boxes — except Netflix.



NordVPN The all-rounder.

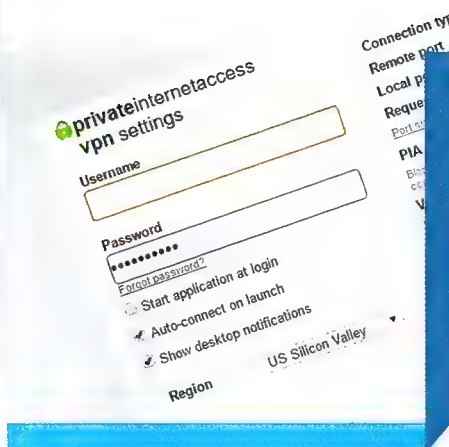
NordVPN is a service that ticks all our boxes: Netflix support, no logging, global reach, proxy servers, kill switch, unthrottled peer-to-peer and high speeds. Connecting to servers in the US and AU, we consistently hit speeds over 23Mbps, which is more than enough for HD Netflix streaming. NordVPN also offers the ultimate in anonymity: not just anonymous sign-ups with Bitcoin but also a unique Tor-over-VPN service that hides your online activity even from NordVPN. Not every NordVPN server will defeat the Netflix block, and you will likely have to contact support to find a server — although heading to nordvpn.com/servers and looking for 'Ultra Fast TV' can get you started, too.

The client itself is fantastic, but our favourite part is that it lists servers by current load, as well as the useful map selector for the location. That makes choosing a server easier than the usual lottery. You can also let it auto-choose, which will connect you to the closest server with the lowest load in your country of choice.

Verdict

It has all the things you'd want in a VPN.





US\$7 PER MONTH, US\$40 FOR A FULL YEAR
PRIVATEINTERNETACCESS.COM

Countries served: 25; Netflix support: No;
 Clients: Windows, MacOS, Android, iOS, Linux,
 Chrome; Simultaneous connections: 5

Private Internet Access

Not what it once was.

Once a darling among VPN subscribers for its low-cost and broad service offering, PIA has had its ups and downs. Even now, server selection is something of a lottery. Connecting to 'California' delivered speeds of just 1.04Mbps at speedtest.net, while connecting to 'Silicon Valley' netted 6.8Mbps. If we went with Auto, it connected us to 'Sydney' (9.4Mbps) and the generic 'US West' hit 8.1Mbps. There's no indication in the client about server loads or recommendations that might help you choose.

PIA is one the ISPs that has given up trying to work around Netflix and Hulu's VPN bans — you simply cannot access these services while connected. Other sites, like the BBC and Amazon still work just fine.

There are elements to like in the basic client. It has a kill switch and leak protection, and the service will also block most ads if you switch on the PIA Mace protection option. PIA also provides SOCKS5 proxies if you just want uncensored web browsing.

Verdict

Affordable, but no Netflix and too much of a server lottery.



US\$10 PER MONTH, US\$48 FOR A FULL YEAR
WWW.SLICKVPN.COM

Countries served: 35; Netflix support: Yes;
 Clients: Windows, MacOS;
 Simultaneous connections: 5

SlickVPN

An affordable Netflix solution.

With a very affordable annual charge and continued support for Netflix, SlickVPN offers excellent value for money. It also offered some pretty good speeds when we tested it. Connecting to the Sydney server, we hit 15.3Mbps; connecting to Los Angeles we hit 11.3Mbps. According to SlickVPN, there's no throttling on P2P traffic, either. SlickVPN also offers anonymous sign-up with Bitcoin.

It's also one of the services that still offers support for Netflix and Hulu. As with most providers, you'll have to ask which servers to use, but support is available on SlickVPN's website 24/7. After getting the information from support, we had it up and streaming Netflix US in HD with no problems.

The client itself is relatively basic, with no kill switch or ad-filtering. In preferences, you can turn on DNS leak protection, as well as the Balancing option, which will let the client automatically choose a server based on current load (which is useful if you just want the best speed).

Verdict

An affordable way to get Netflix US and Hulu and the speeds aren't too shabby.



US\$10 PER MONTH, US\$60 FOR A FULL YEAR
(US\$6/US\$47 FOR JUST ANONYMOUS PROXY)
TORGUARD.NET

Countries served: 50; Netflix support: Yes;
 Clients: Windows, MacOS, Android, iOS, Linux;
 Simultaneous connections: 5

TorGuard

More privacy features than most.

Although it has Tor right there in the name, there is actually no association with the anonymising network; TorGuard is a largely conventional VPN service (the 'Tor' is apparently a reference to 'Torrents'). It does offer a few features not available from other providers, which can make it a compelling choice for the security-conscious. For people looking for anonymous web browsing, it offers a comprehensive SOCKS5 proxy service with servers available worldwide. The VPN service also comes with an encrypted web mail service with full PGP support and 10MB of mail storage.

TorGuard also offers a 'stealth' service that strips out potentially identifying header information from the data from its networks, so that nobody can know the data came through a VPN. It claims that this can defeat things like China's packet inspection. You can also access Netflix on TorGuard — quite smoothly, in fact. The speeds across the board were very good: we connected with Los Angeles at just over 12Mbps. ■

Verdict

A smooth service, with Netflix support and some unique security options.





» tunnelbear vpn

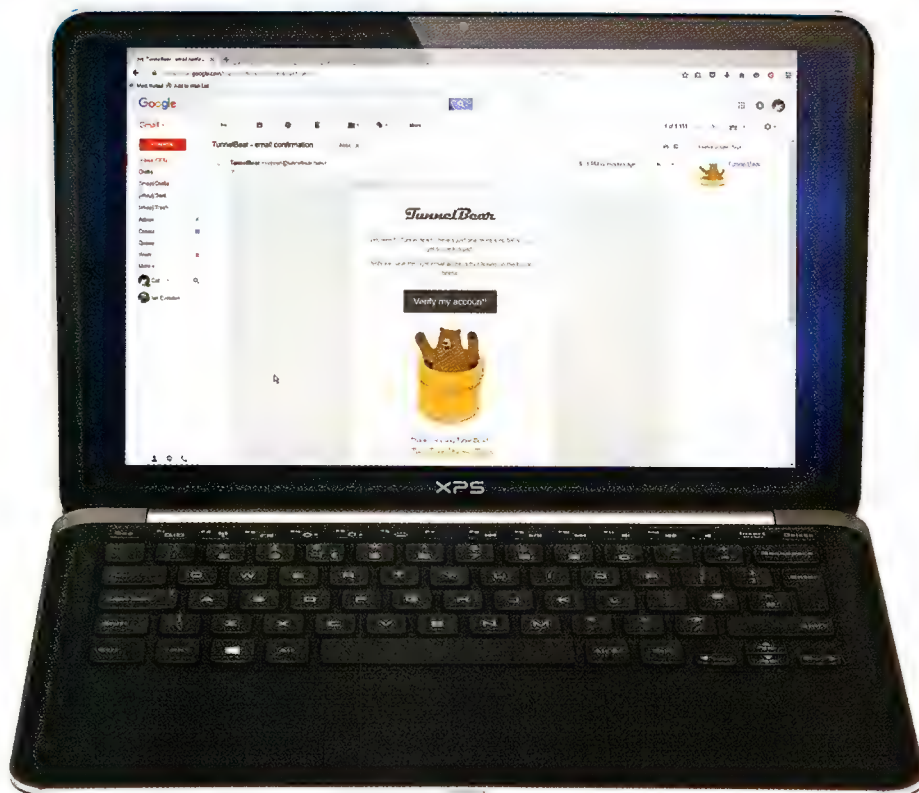
Get set up with the free TunnelBear VPN

Cat Ellis recommends getting this free Windows VPN, which stops people tracking you online and stealing login details.

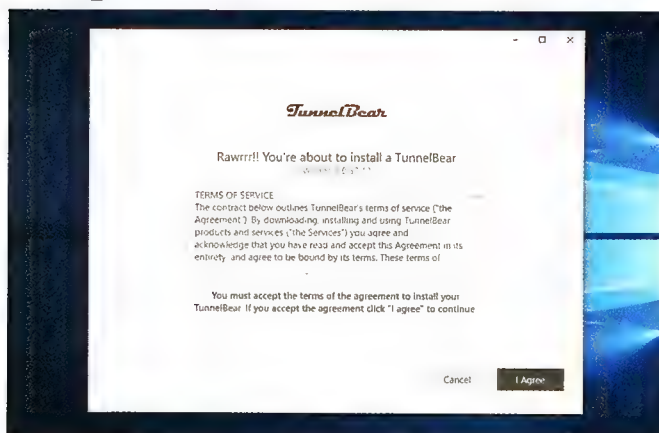
When you use the internet, there are many potential weak points where the information you send could be intercepted by would-be thieves. This is even more of an issue if you're using a public Wi-Fi network in a café or hotel where you can't secure the router yourself.

Protecting your IP address is also a concern. This is a number assigned to the device you're using to access the internet, which can be used to determine your physical location and, together with small pieces of data called cookies, to track which websites you're visiting.

You can avoid these security risks by using a virtual private network (VPN), such as TunnelBear, which redirects data from your computer via another location to hide your identity. A VPN also encrypts all the data it transfers, and works with your regular web browser.

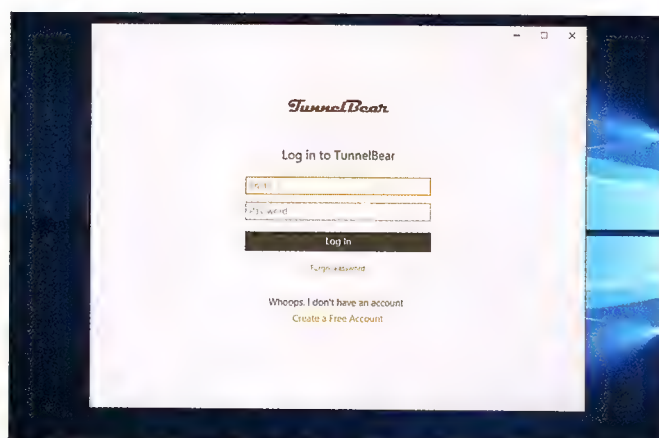


Dig your first tunnel



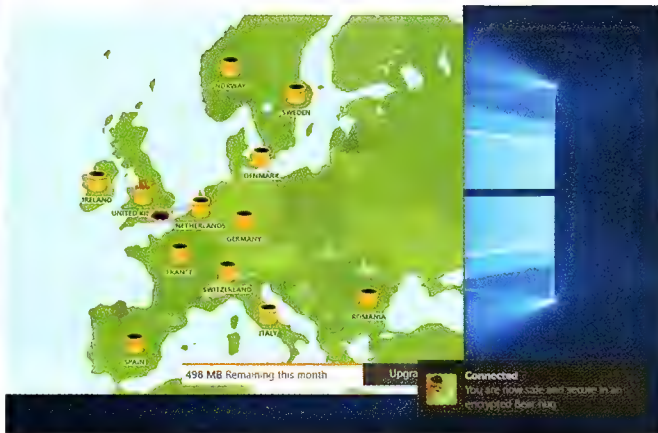
1 THE BEAR NECESSITIES

First, download TunnelBear from downloads.techradar.com/downloads/tunnelbear and run the installer (you'll need 63MB free space on your storage drive). This free version of TunnelBear gives 500MB of data per month, which is enough for regular browsing, but not for downloading large files or streaming video, so it's best to save it for online shopping and banking.



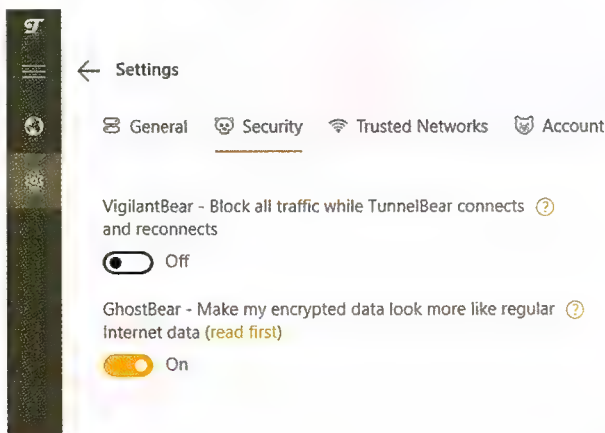
2 REGISTER AND CONFIRM

Once you've installed TunnelBear, you'll be prompted to create an account by entering your first name, email address and a password. You can also add a Twitter username, so you can tweet about TunnelBear and receive an extra 1GB of data. Go to your email account and you'll see a confirmation email containing an activation link. Click this, reopen TunnelBear and click Done.



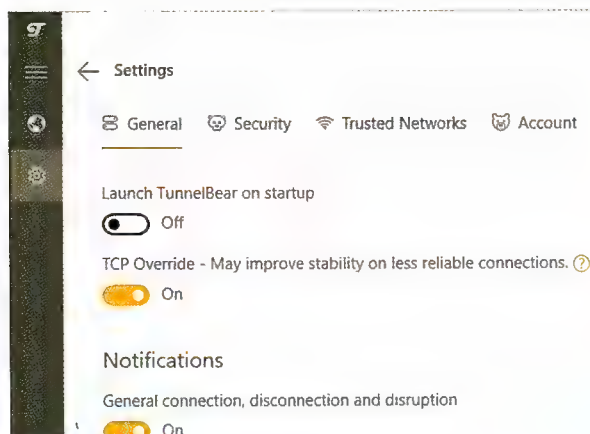
1 START TUNNELLING

Some VPN tools need a lot of configuration, not TunnelBear! To activate it, click the On/Off toggle (or set it to Auto), and it will connect to your nearest 'tunnel'. This is the location your web browsing will appear to come from. When a confirmation notice appears in the bottom right, you can start using your regular web browser and TunnelBear will redirect everything.



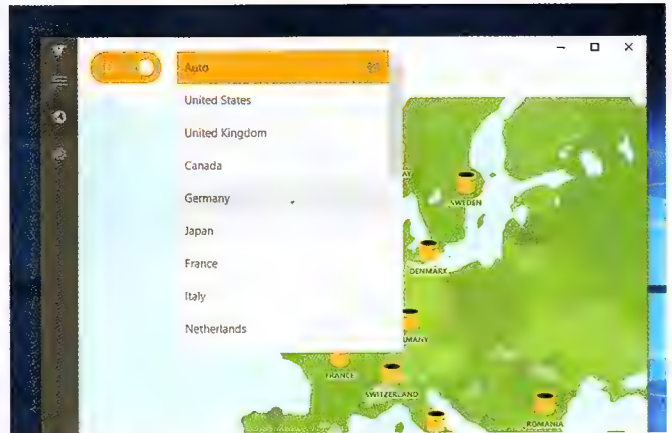
3 GO GHOST

TunnelBear now includes a GhostBear option, which makes it harder for businesses, ISPs and even governments to tell that you're using VPN encryption. To use it, click the Settings icon in the left-hand sidebar and then set the GhostBear toggle to 'On'. The slight drawback is that this will slow your connection speed. You only need this on sites and in locations that block VPNs.



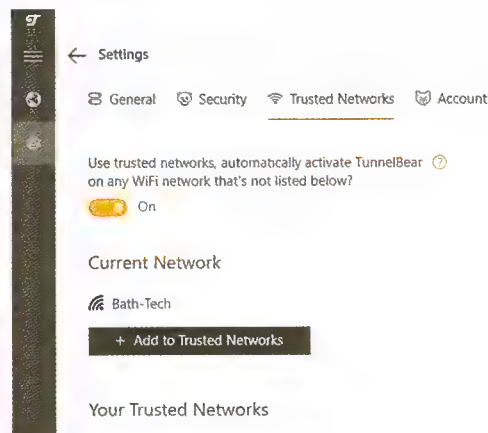
5 SMOOTH CHOPPY CONNECTIONS

Another option under 'Settings > General' is 'TCP Override', which helps to compensate if your Internet connection keeps dropping. The overall performance is slower, but the signal should be steadier, so give it a try if your connection is choppy. If you're still having problems, switch TunnelBear off and on again. It's a cliché, but sometimes it helps to reset the connection.



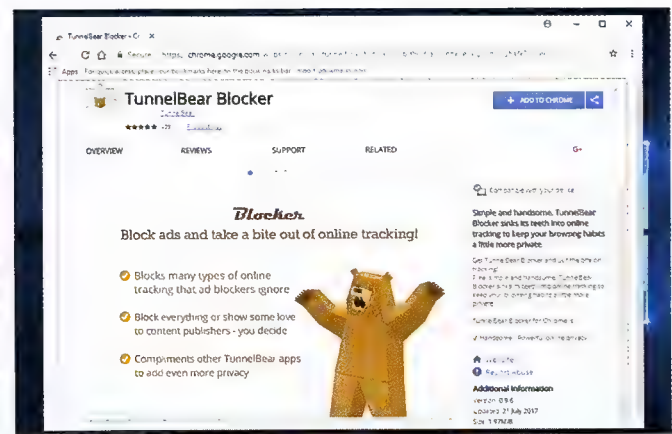
2 MOVE OVERSEAS

Your nearest tunnel is probably in your home country, but you might want to appear further afield. Click 'Auto' to see a list of countries. Select one, then wait a moment and TunnelBear will start re-routing your browsing via the new location. This can also be handy if you're on holiday abroad and want to access a website that's only available in your country.



4 CONNECTION OPTIONS

Still in Settings, select the Trusted Networks tab and toggle the 'Use trusted networks, automatically activate TunnelBear on any WiFi network that is not listed below' to 'On'. This ensures that, when you connect to a public Wi-Fi network, TunnelBear will activate automatically. Click '+ Add to Trusted Networks' to add any Wi-Fi connections you do trust — such as your home network.



6 A BEAR FOR YOUR BROWSER

If you like using TunnelBear, it's also available as an extension for Google Chrome and Opera (search for it in their add-on stores). This has the advantage of only tunnelling your browser activity — it won't divert things such as software updates that Windows performs in the background, helping to conserve your monthly data allocation.

SUBSCRIBE & GET APC FROM ONLY \$5.33 AN ISSUE!

12 ISSUES FOR ONLY \$69!

WHY SUBSCRIBE?

- Take advantage of our trial subscription offer of six issues for \$45 if you choose to auto-renew*
- Get 12 issues of Australia's favourite tech mag for only \$69!
- Take out a 2-year subscription and get 24 issues for \$128 — that's only \$5.33 per issue!
- Free delivery of every issue straight to your door
- Free full-version software downloads with every issue

SAVE UP TO \$110!



**FREE DELIVERY TO YOUR HOME
OR OFFICE EACH MONTH**

HURRY

OFFER ENDS FEB 28TH, 2018!

TWO EASY WAYS TO SUBSCRIBE TO APC MAGAZINE
VISIT WWW.MAGSHOP.COM.AU/FUTURE OR CALL 13 61 16
AND QUOTE M1802APC

TERMS & CONDITIONS This offer expires February 28th, 2018, and is available to subscribers within Australia only. Please allow 6-8 weeks for delivery of your first issue. For full terms and conditions, see www.magshop.com.au/future. Please see our privacy policy on page 3. *Six issues for \$45, then \$45 charged to your credit or debit card every six issues thereafter on auto-renewal.

COMPUTER & SUPERCOMPUTER: The future of the PC

Will we still have personal computers in the future, and if so what forms might they take? Ian Evenden investigates.



Twenty years ago, when PCs were universally beige, and APC's staff had a lot more hair, we probably would have nodded in agreement if someone had told us that the desktop's days were numbered. We'd used laptops, we'd heard about Moore's law, we knew things didn't get much better than Windows 95. It stood to reason that portable computers would take over, and that 17-inch CRT we could barely carry up the stairs would soon be on its way to the dump. That's partly correct, as we thank any passing deity for flatscreens, but the desktop PC is still with us, and is really the only way to go if you want no-compromise computing power, be that for gaming, 3D content creation or 4K video editing.

the » the future of the pc

Laptops are fine, and our phones and tablets have come a phenomenally long way, but there's always something that holds them back, be it insufficient cooling, limited RAM, the drawbacks of mobile processors or, in the case of touchscreen devices, an unintuitive user interface.

So the desktop endures, looking much the same as it did in the days of the 80286, only rotated 90° into tower cases, and with more fans and lights, and a whopping great water block. Will it still be purring away on our desks in another 20 years, though?

One future route is already happening with the advent of cloud computing. Our PCs could become dumb terminals, akin to the thin clients of old, tapping into the huge processing and storage potential of data centres using high-speed wireless connections. They could all become touchscreen devices, small enough to tuck away in our pockets, then unfolding to gigantic size like some Tony Stark creation. They could be implanted into us, like something out of Iain M Banks's *Culture* novels or an episode of *Black Mirror*, connecting us to a central hub, and with a display like that of a smartphone constantly projected into our vision.

Or maybe they'll just stay the same, doubling in power every two years, and needing a new GPU even sooner. We went looking for answers.

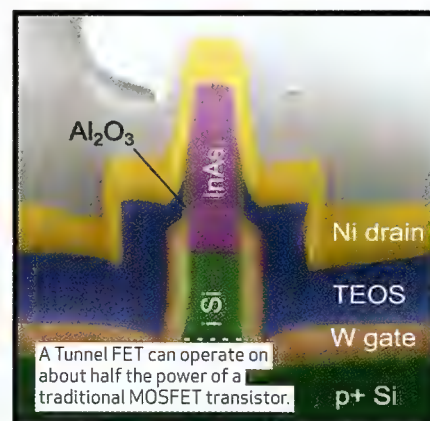
UP CLOSE AND PERSONAL

The term 'PC' has evolved from meaning any type of personal computer to specifically those involving X86 processors and running Windows. Elsewhere, X86 + Unix = either Mac or Linux, ARM + Unix = iOS or Android, and ARM + Windows = discontinued. But those ARM chips

are what's got Samsung poised to overtake Intel as the world's biggest processor manufacturer, and isn't the smartphone in your pocket as much of a personal computer as the one on your desk?

Many developments in future PC components are extensions of things we're already familiar with: greater efficiency, using less power, and increased parallelism. A Ryzen 1800X may have eight cores, but a GTX 1080 Ti has 3,585. Yet while AMD's silicon is general-purpose, Nvidia's is specialised for graphics computations. Bringing this kind of parallel computing power to the mainstream, via something such as Nvidia's CUDA, Microsoft's DirectCompute or other GPGPU programming languages, is a step in the direction of what's predicted for the immediate future of our PCs. Then there's 3D chips, such as those seen in Xpoint or the vertical stacks of AMD's HBM — these are about more efficient use of space, as well as, in the case of Xpoint, making use of a new approach to operating a memory chip. These technologies are here now, even if they're not widely available. Future technologies will take these innovations, and turn up the volume.

Looking ahead, by 2035, we should have cracked thermodynamically reversible computing — that is, logical operations that can be run backward from their result, because nothing is destroyed in their operation, and they don't increase entropy. This sounds a bit crazy — and is really only the tip of a whole iceberg of crazy — so we spoke to Professor Robin Hanson of George Mason University in Virginia, who is also a research associate at the Future of Humanity Institute of Oxford University in the UK, in an attempt to understand.



"When we run an engine, entropy is increasing," he says, prompting a trip to Google immediately. Entropy, it seems, is the amount of energy in a system that's wasted, unavailable to do work. The professor continues: "But if we want to reduce how much entropy increases, the slower we make the engine go, and the closer we can come to what's called a reversible process, where you could have made it go backward and got back to the original state. That's also true for computers: Almost all logic gate operations take two bits in and they send one bit out, therefore implicitly erasing one bit, and increasing entropy. Typically, we're erasing far more than one bit per gate operation, but that number has been declining over time."

This is where the year 2035 comes in — if you plot the number of bits erased by transistor operations on a graph, and continue the line into the future, it's a mere 18 years until it reaches one. "At that point," Prof Hanson continues, "we could keep reducing it, but we'll have to switch to reversible computing, where we have two bits in and two bits out, with nothing erased. Once we switch to reversible gates and reversible computers, then we can continue to reduce the amount of entropy per gate operation, but it will be because we run the gate more slowly. If you take the same gate, but take twice the time to do the gate operation, then it erases half as many bits. So when hardware gets cheaper, and energy gets cheaper, you will spend half of it on having more hardware, and half of it on running things more slowly."

So what we are looking at are lots of slow, parallel processors, rather than the small groups of screamingly fast cores we see today. But that's not all: It will change the upgrade cycles, and what we budget for. "At that point, the rate at which technology improves, or hardware costs go down, is half as fast as it has been so far," says Prof Hanson. "Up until recently, energy hasn't really been the main cost — that's been the hardware itself."

"The Tunnel FET looks like a MOSFET, and you can build a lot of the same circuitry with them."

Dr Kirsten Moselund





Quantum computing

The theory of quantum computing has been understood for a while now. Instead of using traditional transistor gates that can be in one of two states, 1 or 0, a quantum bit or 'qubit' can be both at the same time, neither or any combination. This hugely speeds up processing for certain calculations.

It comes at a cost, though: cooling. One method of building a quantum computer involves superconductors, and they need to be very cold — just above absolute zero. A water block isn't going to cut it. The cooling system is about the size of a hot water cylinder, even though the processor is less than an inch across. Then there's

the 'trapped ion' approach. This uses laser beams to trap and measure ions, which can be induced to carry out calculations thanks to quantum entanglement. This needs less cooling, but the machines can still be very large.

According to one researcher we spoke to on the subject, an interpretation of how quantum computing works is that it makes use of computations across parallel universes. By doing this, it can solve certain problems in maybe just a few hours that even the fastest supercomputer in the world today would take billions of years to calculate.

Which sounds fantastic, but there are, inevitably, some problems. One is the sheer

size, which we can expect to come down as the technology matures, and another is that, for the uses that you and your dog have for computers, there's simply no benefit in using a quantum model. The algorithm being processed needs to be specifically written to take advantage of the processor. So while you'll probably never check Facebook, edit video, or play a game on a quantum computer, you may very well interact with an AI running on one. And the technically minded can use a five-qubit quantum computer today at quantumexperience.ng.bluemix.net/qx/experience

And so, every time the hardware is capable of running twice as fast, the computers are twice as fast. But with reversible computing, every time the hardware gets four times as fast, instead of running the computers four times faster, we will instead have twice as many of them running at half the speed. This means Moore's law will slow down by a factor of two."

Moore's law, which predicts a doubling of computing capacity over a period of two years, is already starting to break down in areas such as the speed of gate operations, but holds strong in the amount of energy used per operation. Many scientists are

looking at ways to improve the rate of speed increase, and decrease the energy usage, through the use of new materials in chip design, and by changing the design of the transistors themselves. IBM researchers in the US are attempting to press nano-technology, such as carbon nanotubes, into service, while in Switzerland, Big Blue is testing out other naturally occurring elements, known as III-V materials.

BACK TO SCHOOL

Picture the periodic table thumbtacked to the wall of your science class in high school. Silicon sits in the fourth

column, with columns III and V to either side. Many elements from both sides, when made into compounds, form very stable chemical bonds, and are semiconductors, like silicon, which means that although, in their natural state, they don't allow electricity to flow through them, they can be 'doped' with another element to allow it, and this can be done in a controllable way. A lot of this is still exploratory science, but you may already own a piece of technology based on this idea — the laser diodes inside Blu-ray drives are made from gallium nitride — and hopefully more should come to fruition before 2035.



Electronic blood

Another project coming out of IBM's Zurich labs will be of interest to anyone who's ever filled up a water-cooling reservoir and worried about spillage. Electronic blood is a fluid that circulates through the microchips themselves, drawing away heat, while at the same time providing power. In another example of hardware/wetware convergence, this is much the same way our brains work.

Using it means a change in the design of chips, so they contain microchannels that the 'blood' can pass through to achieve laminar flow — an orderly, low-speed movement of the liquid

in parallel layers, without any eddies or turbulence forming. It could change the underside of a chip, too — more of the 1,000-odd pins on the backside of a CPU are dedicated to power delivery than are for data flow. IBM is using 3D printing to produce its tiny cooling networks cheaply. Perhaps the biggest change this could bring to PCs, however, would be in density. At the moment, we need large surface areas for contact with heat spreaders or active coolers. With the cooling fluid moving across inner surfaces, we could stack chips like a five-patty burger, and let the sauce — or maybe the cheese — take care of heat and power. This would cut

down on the amount of good fresh air inside our PC cases, as well as using only a single pump, reducing noise levels in the process.

The fluid itself is made from chemicals with names like dihydroxyanthraquinone, and by acting as an electrolyte, and being charged as it passes electrodes, it's capable of supplying one watt of power, once pumping overheads are subtracted. This doesn't sound much in these days of 1,000W PSUs, but it's enough to power microprocessors, and the LEDs and lasers used in fibre-optic networks.

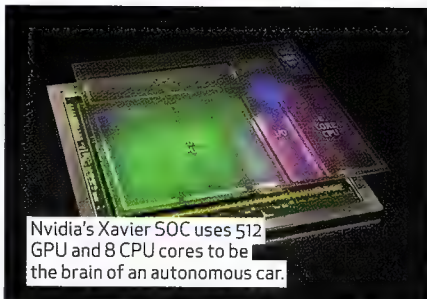
"The speed at which you can turn on a MOSFET is inherently limited," says Dr Kirsten Moselund from IBM Research. This is the breakdown in Moore's law mentioned above — the MOSFET, or metal oxide semiconductor field effect transistor, is the type of transistor most commonly used in a silicon chip, first patented back in 1925. "It doesn't matter what you make it out of, it's a physical limitation," she continues. "As we scale down our devices, we also want to scale down voltages, but it's very hard to scale down power beyond 60mV — you start to get into trouble. There are lots of people looking into this, because it's beyond all the technical difficulties

of scaling, it's something physical. And scaling down the voltages is probably the most important parameter for energy efficiency."

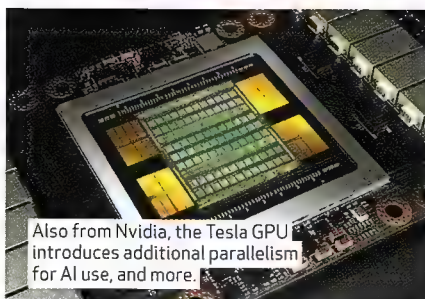
The search for a way around this has led Dr Moselund and her team to Tunnel FETs, a type of transistor that exploits the ability of electrons to tunnel through a barrier if that barrier is thin enough. This is quantum mechanics in action, making use of a strange property of electrons — that they can be either waves or particles.

"The Tunnel FET looks like a MOSFET, and you can build a lot of the same circuitry with them," says Dr Moselund. "But as it operates on a different principle, in theory you don't

have the same limitations." Indeed, a Tunnel FET can operate on only about half the power of a MOSFET — in simulations, at least. These transistors are made from, you guessed it, those III-V materials — indium arsenide and gallium antimonide are common choices. "III-Vs have a lot of really nice benefits," Moselund continues. "There are lots of them, and they have different properties, but what's generally good about them is many have very high electron mobilities [how quickly an electron, and therefore a current, can move through them], so you can trade speed for lower power, and many are optically active, so you can make lasers out of them,



Nvidia's Xavier SOC uses 512 GPU and 8 CPU cores to be the brain of an autonomous car.



Also from Nvidia, the Tesla GPU introduces additional parallelism for AI use, and more.

which you can't do with silicon." Lasers are obviously great, but modern electronic devices have another problem — they leak. This is why they get hot and drain their batteries when you're not using them. The gates in the transistors don't shut completely, allowing small amounts of power to trickle through like a leaky faucet. Tunnel FETs and III-V materials have a greater ability to turn themselves off all the way, decreasing leakage and power loss.

The new materials don't completely replace existing ones; they're integrated into the silicon in a way that boosts its electron mobility, to increase performance at 7nm and smaller, meaning existing manufacturing processes can still be used. IBM, GlobalFoundries, and Samsung debuted a silicon wafer etched with a 5nm process earlier this year. The III-V materials are grown as crystals on a silicon substrate, then a process known as 'epitaxy' deposits more material on top, forming structures such as nanowires and junctions, and even stacking them on top of one another. You can also mix up the recipe — what Mosehund calls 'tuning' — blending, say, 50% arsenic with 20% gallium and 30% indium, with a specific use in mind.

It's not just the structure of microchips that will change; the way computers are put together and treated is also in for a revolution. Professor Hanson believes that computers will one day be able to simulate and go far beyond the capabilities of the human brain. He calls these emulations 'Ems' and his concept is not a little thought-provoking: When computing is advanced enough, it will out-compete humanity.

"A natural result is that humans will have to retire," says Hanson. "They're just not competitive. They could still work, they just can't earn much money that way. Collectively, humans get very rich very fast, that is, they own almost all the capital in this world, and if the economy doubles almost every month, human wealth doubles every month. For individual humans who don't own any wealth, that zero keeps doubling to zero, and those people are at risk of starving unless

they acquire some insurance, assets or sharing arrangements. But collectively humans get very rich very fast.

EM POWER

"The Ems, however, they do not get rich," he says. "Their population quickly expands and wages stay at subsistence levels, but they are mostly OK with that — subsistence wages have been the usual case in human history. They're earning enough to pay the power bill, the cooling bill, the hardware rental, the communication line bill... which will presumably come in one big package."

This is treading rather closer to philosophy and economic theory than we're used to, so in an attempt to drag it back to more familiar terms of reference, we ask Hanson whether he thinks there's a future for the desktop PC. And he does. Kind of.

"A lot of people will continue to do office work at desks — it's kind of comfortable to sit in a chair," he says. "And they will want something around them to act as the interface to the computer they work with. Now, whether the computer is just sitting on the wall, or in their hands, or on the desk, that's much harder to say. They could have a box next to them or a server down the hall — it hardly matters from the point of view of them interacting with the computer. I like to use the same computer at home and in the office, so I prefer a laptop, but the incentive to use a laptop will get less the more reliable cloud services get."

Hanson goes on to imagine cities that glow red hot because they're occupied by the hardware and cooling needed to run Ems, with humans banished to more habitable parts of the globe, but the inference is clear — in the near term, PCs will continue to get more powerful, integrating new materials and structures into their designs. But as the cloud gets more important and reliable, and communication links get faster, a transition to something like today's supercomputer model could occur, with virtual computers held in the cloud, and eventually virtual workers there, too. It's safe for now, but the days of the desktop PC could ultimately be numbered. Sorry. ■

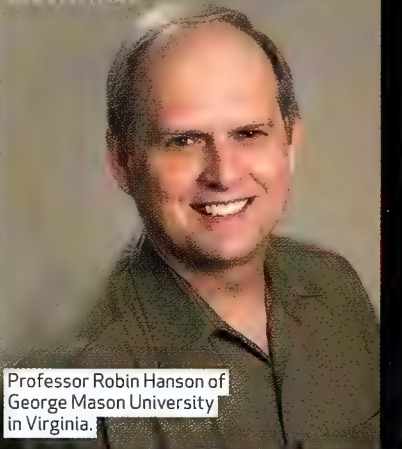
Matter of ethics

One argument that can be drawn out of Hanson's work is whether these brain emulations would be conscious. After all, if the Ems do all the work, and humans retire and live on the profits, isn't there a word for that? As in *Star Wars*, where an army of apparently sentient droids obeys and are the property of the biological creatures, would we be condemning them to a nightmare of our own making?

The question of whether computers will be conscious may never be answered. Hanson asserts there's no way to tell. "If we mean it in the informal descriptive sense, of having some sense of self like humans do, that you can ask questions like: 'What did you do yesterday?' or 'How did you feel about that?' then most computers are like that. And we could create computers that are more like that."

"If you mean there's something about a human that feels in addition to how it behaves, what it remembers, and its coherent story of itself, and these feelings are not reducible to plans, memories, or calculations, but are something else that's a part of us that's not included in the computery parts of ourselves, that there's some extra part of humans beyond the physical, we'll never really know about what causes it or where it comes from."

"You'll probably never really know if anybody you meet ever feels; the left side of your brain never knows whether the right side of your brain feels, and the you of today can never really know if the you of the past or the future really feels. All you know about these things comes through physical channels. And if people still think these questions make sense in the age of Ems, they will still disagree about it then."



Professor Robin Hanson of George Mason University in Virginia.

COLLECTABLE POSTERS!



THE BUILDER'S GUIDE TO **MINECRAFT**

PS4 • XBOX ONE • SWITCH • 360 • PS VITA • IOS • ANDROID

**BRAND NEW
BUILDS FOR 2018!**

Super-fast projects
to bring your
maps to life

**10 SURVIVAL
MODE TACTICS**

We show you how to
survive and thrive!

BETTER TOGETHER!

**MINECRAFT'S MASSIVE UPDATE - PLAY WITH
YOUR MATES ON PC, MOBILE, XBOX AND MORE!**

**AT ALL GOOD
NEWSAGENTS!**

**MAKE MINECRAFT
LOOK AMAZING
TRICKY TRAPS TO
SNARE YOUR FOES**

FEATURING



CLOSE ENCOUNTERS
In search of the ultimate alien!



SUPER SHADERS
Create fantastic landscapes



NOT LIKE THIS...
The worst ways to die in Minecraft



- SURVIVAL TACTICS
- BRAND NEW BUILDS FOR 2018
- CLOSE ENCOUNTER
- SUPER SHADERS
- FOUR PULL-OUT POSTERS
AND MUCH MORE!

**ISSUE 19
OUT NOW
ONLY \$8.95!**



Resurrect your old Android with LineageOS

When Google leaves your smartphone without updates, open source and Neil Mohr save the day.

There's a joke that circulates security circles: Android smartphones are really expensive abandoned Linux distributions. It hurts, but it's true. Android is based on the Linux kernel, making Android (more or less) a form of Linux operating system, aka a distribution. Android smartphone manufacturers tend to bash out a device, build whatever the latest version of Android is, support it for the shortest amount of time they can get away with, then abandon the owners – vulnerable to whatever zero-day attack next raises its ugly head – running for the hills, waving their wads of cash.

Take the OnePlus Two. A fine Android phone, but OnePlus dropped support two years after release, just as the Krack vulnerability struck. Tough luck, suckers! This is standard practice in the Android world. But when people are carrying their entire lives around with them on a security-hole-riddled device, perhaps it's time to rethink the situation. So what can you do?

While you could say a failing of Android – contrasted with Apple iOS – is its easy-to-build-and-forget open-source nature, it means any group can support any devices via the Android Open Source Program (AOSP). And people do. Most famously, there was Cyanogenmod, which blossomed into a huge project, creating builds of Android supporting hundreds of devices, with far more up-to-date releases. But the project closed in December 2016, when the corporate branch that had sprung up shut down the servers that hosted the images, source code, wiki and so on. That's where its spiritual and source code successor LineageOS rises phoenix-like from the server ashes to power your devices.

feature » resurrect your old android with lineageos

That's the power of open source — while one group might shut down development, another is free to pick things up and carry on where they left off. It took a few months through the start of 2017 for servers to be established, websites to spin up, and development to pick up, but as we start 2018, LineageOS officially supports almost 200 devices, with many more through unofficial development. See the boxout opposite on how to find out what devices are supported, and what to consider when buying a device.

As with Cyanogenmod, LineageOS is built upon the AOSP; the devs take the latest release, which has all the Google software removed, add LineageOS's own additions, create a build for specific devices, and roll out an image update. This means that, when a zero-day is issue announced, such as the critical Krack and Blueborne vulnerabilities, LineageOS developers can roll out an update within days, rather than the weeks, months or never-ever option big-name Android

manufacturers can take, despite having weeks of embargoed warning.

So who should consider flashing their phone with LineageOS? Probably not your grandmother. We don't like being presumptuous, but it's probably not for her. If your device is still under warranty, wait until it's not. This type of activity voids any cover you might have, and that would be foolish. The process will likely have your phone out of action for at least half a day; if you've never done this type of thing before, more likely a full day — don't forget, there's an element of having to reinstall all your apps, tweak things, curse when something isn't quite right, and start again. It all takes time.

If you've decided that flashing LineageOS on your phone is for you, first make sure your phone is supported; there's not much use carrying on if it's not! Head to <https://wiki.lineageos.org/devices>, and see whether your device is on the official supported list. If it is, you're golden; if it's not, don't give up hope just yet. Consider this list to be tier-one

supported devices; because this is open source, less popular devices can often gain support via the <https://forum.xda-developers.com> community.

A Google search such as "xda developers <phone model> lineageos" will garner results. Read any returned forum threads to determine how good the support is — hopefully, people will report common bugs or issues. Common issues are the phone, Wi-Fi, Bluetooth or camera not working — these typically require proprietary binaries to work that may not have been merged into early builds. Other issues include locking up, poor battery life and other quirks.

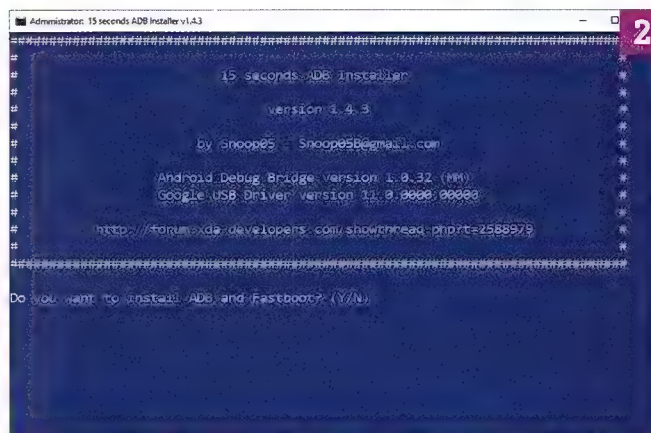
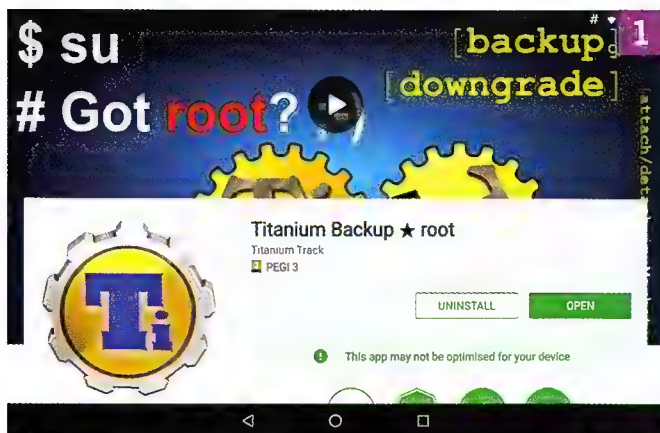
The former issues are likely to be deal-breakers, while you might decide you can live with the latter issues. Having used early builds on a number of devices, they usually work relatively well — as long as you have the basic mobile phone radio operational. But you need to decide for yourself whether an 'alpha' or 'beta' build is going to be good enough.

How do you get LineageOS on your device?

The general overall process looks like this; we'll go into tools and details shortly...

- 1 BACK UP YOUR DEVICE**
If anything goes wrong, you'll want an escape plan.
- 2 GET THE TOOLS AND DRIVERS**
- 3 UNLOCK YOUR DEVICE**
This wipes everything.
- 4 INSTALL A NEW RECOVERY ROM**
Typically, this is TWRP.
- 5 COPY LINEAGEOS AND GAPPS TO THE DEVICE**
- 6 WIPE THE CACHE, FLASH THE DEVICE, REBOOT**
- 7 WAIT...**





1 BACK UP YOUR DEVICE

If something goes wrong, and you've backed up your device, you can restore it back to its existing state, data, apps and all.

- For the lazy, you might just want to back up your data with an app. We recommend My Backup (play.google.com/store/apps/details?id=com.rerware.android.MyBackup), which has free and paid versions. If you know how to root your device, Titanium Backup (play.google.com/store/apps/details?id=com.keramidas.TitaniumBackup) is more comprehensive.
- Do you use Two Factor Authentication (TFA) or Google Authenticator? Stop now. You'll lose access and need to re-enable all your TFA-protected services. If you have rooted your device, you can use Titanium Backup [Image 1] to save off the keys, then restore them afterward. Otherwise, list your TFA-protected services, and either save off the keys or turn TFA off until you're back.
- For the super-lazy, Google backs up your device to the cloud to a degree; when LineageOS is installed, you'll get the chance to log in to your Google Account and have it restore the apps and settings. Great in principle, a bit hit and miss in practice.
- Do you want to back up your text messages and call history? Then use a dedicated backup tool. Another good one is SMS Backup & Restore (play.google.com/store/apps/details?id=com.riteshsahu.SMSBackupRestore).
- Full system images are possible, but only via a suitable recovery ROM, such as TWRP (we'll cover this shortly) or ClockworkMod. However, unless you already have one installed, installing one requires the device being wiped in the first place. Thanks, Google!

2 GET THE TOOLS AND DRIVERS

With a suitable backup done, you're ready to scoop out the brains of your device, and replace them with something altogether better. To perform such a delicate operation, you need the right tools. This tends to be easier on Linux, but we'll use Windows here for simplicity.

- The two core command-line tools used to monkey with Android devices are Adb (Android Debug Bridge) [Image 2] and Fastboot. You can download these from Google at developer.android.com/studio/releases/platform-tools.html. There's a bunch of other junk in the ZIP that you can safely ignore. Adb is designed to interface and control the Android OS – in other words, Android needs to be running on the device to work. Fastboot is a low-level tool that controls the basic recovery mode access, known as fastboot, on powerup – like your PC's BIOS.
- The Android ADB driver for Windows is used to recognise the Android device in debug mode, so you need the correct driver. You can get a generic one from github.com/koush/support-wiki/wiki/Android-ADB-Drivers. If your device isn't recognised, Google maintains a list of OEM-specific drivers you can try at developer.android.com/studio/run/oem-usb.html#Drivers.
- XDA developers have created an all-in-one tool and driver installer (forum.xda-developers.com/showthread.php?t=2588979). You may want to opt for that to save your sanity!

"Make sure your phone is supported; there's not much use carrying on if it's not!"

Device support

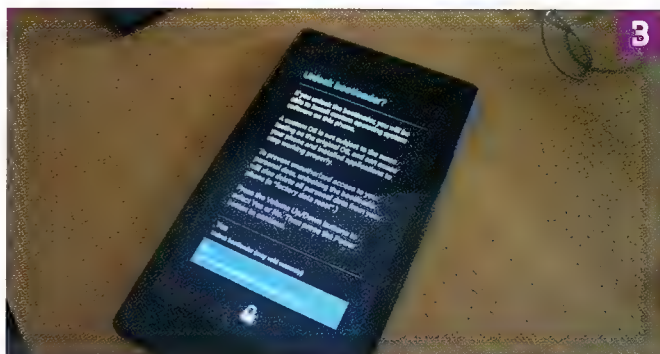
We strongly suggest you keep LineageOS support in mind next time you buy an Android device, so once the manufacturer feels it can drop your support like a tonne of bricked phones, you have the option of flashing an alternative OS that continues to be supported. LineageOS support tends to go to popular devices. Take a look at the official list at wiki.lineageos.org/devices to get a feel for what is popular: Google devices, Samsung Galaxy S, Note and Tab ranges, OnePlus, most Motorola Moto devices, LG, the HTC One and Sony Z ranges, among others.

Another consideration is can you flash your device? Almost all manufacturers now offer a (legally required) process to unlock the device, but it varies from one manufacturer to another, and even between devices. Remember, unlocking an Android device wipes everything, and causes a factory reset. You have been warned.

A few examples:

- Motorola has a dedicated site with clear instructions, which sends you a device unlock code: motorola-global-portal.custhelp.com/app/standalone/bootloader/unlock-your-device-a
- HTC has its site here: www.htcdev.com/register
- Sony is here: developer.sonymobile.com/unlockbootloader
- Samsung devices are best done via the XDA Odin tool from: odindownload.com/download
- OnePlus and Google devices are unlocked via the fastboot command, outlined in the main walkthrough.

feature » resurrect your old android with lineageos



3 UNLOCK YOUR DEVICE

Now we're all primed, the first major step is to unlock your device. This wipes everything, resetting the device back to factory defaults. Consider yourself warned. Annoyingly, it seems that every manufacturer provides a different unlock mechanism — see the 'Device Support' boxout on the previous page for more details. We're going to follow the default Android system that is used by Google and OnePlus.

- To begin, we need to activate Developer mode, and switch on USB Debugging. In Android, select 'Settings > About' and tap the build number seven times. A message announces that Developer mode is unlocked. Select 'Settings > Developer option switch on USB debugging'. If there's a OEM unlocking option available, select that as well.
- Once USB debugging is on, you've installed the ADB drivers, and

unzipped the tools, connect your Android device. A security message appears on the Android device — allow the connection.

- Select 'Windows', type "CMD" and press Return. 'CD' to where the tools were extracted. For simplicity, you can copy Adb and Fastboot to your desktop, and just work with 'CD desktop'. To reboot into recovery, type "adb reboot bootloader". To unlock, type "fastboot oem unlock". A warning appears [Image 3] — read this, and accept the responsibility, or run screaming into the hills.

4 INSTALL A NEW RECOVERY ROM

You'll want to reboot your Android device and log in — don't worry about accounts, this is just so we can copy over recovery images, LineageOS, and so on. At this point, we're concentrating on adding a custom recovery ROM. This is accessible when a device is first powered up via a key combination, such as Power and Volume Up or Down.



You can also reboot into it via the Adb tool. Using the custom recovery ROM, we're then able to flash a new OS and do complete system backups.

- The most commonly used recovery ROM is TWRP (Team Win Recovery Project), so head to twrp.me/Devices, and download the correct ROM for your device. If one isn't listed, you should try searching for a Clockworkmod recovery image for your device. Copy the recovery image into the same folder as the Fastboot command.
- If you know how to reboot into fastboot recovery, do so. Otherwise, put the device back into USB Debugging mode, as explained in the previous step, and in a command prompt, type "adb reboot bootloader". To flash the recovery image, type "fastboot flash recovery <image file name>". Select to start recovery, and enter TWRP. At this point, you can boot back into 'System', aka Android [Image 4].

Mind the gapps

We've mentioned that AOSP can't include proprietary Google code; the ramifications of that is that a default install of LineageOS doesn't offer Google Play services or any associated Google Android apps you might be familiar with, such as Maps, Keep, Hangouts, Gmail and so on. You do get open-source equivalents of some, such as Calendar and Contacts, but it's not the same if you're switching, and you're going to want access to the Google Play Store.

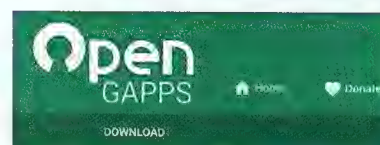
That gaping gap is filled by the Open Gapps project at opengapps.org. This provides a suite of downloads, from a minimal 125MB Pico install that's the base Google Play services, to a full-fat Super package at 860MB, which includes every app ever shipped to a Google device.

You need to choose the correct platform. ARM is 32-bit (similar to x86),

which is most devices out there. ARM64 is for 64-bit devices. These devices and newer are 64-bit: OnePlus Two, Samsung S6/Note 8, Google Nexus 5X/6P, Pixel 1/2. If it offers 4GB of memory, it's likely 64-bit. If it's an Intel Atom, you need the x86 build.

Choose the correct Android version for the release of LineageOS you're installing — probably Android 7.1 — then the variant. We recommend Nano, because you can install just the Google apps you'd like once you're up and running. Avoid Stock, unless you're running a Google device, as the camera app (designed for the Pixel) can go a bit screwy. If you want everything, choose Super or Full.

We recommend you copy and install this alongside the OS image — you can stack up packages to install via TWRP. If you encounter any odd crashes after LineageOS starts, reboot to TWRP Recovery, and clear the ART Cache and Cache to clear this up.

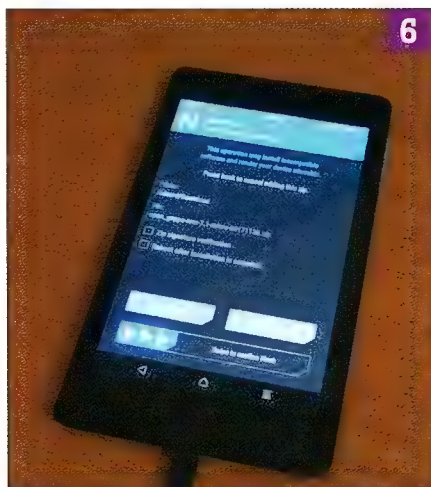
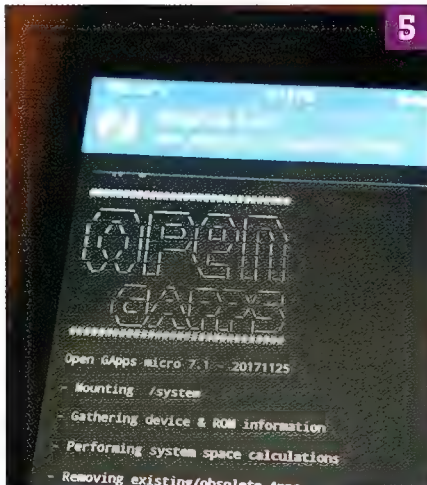


Platform	Android	Variant
☒ ARMv8	☐ 8.0z	☐ aromaz
☐ ARM64	☒ 7.1z	☐ superz
☐ x86z	☐ 7.0z	☐ stockz
☐ x86_64	☐ 6.0z	☐ fullz
	☐ 5.1	☐ miniz
	☐ 5.0z	☒ microz
	☐ 4.4z	☐ nanoz
		☐ picoz

You want Google Play and its privacy snooping services, right? You need to grab the Gapps package, then.

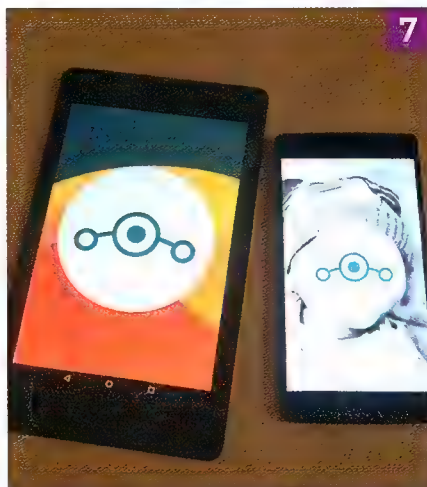
5 COPY LINEAGEOS AND GAPPS TO THE DEVICE

As discussed, download the LineageOS build (wiki.lineageos.org/devices) for your device. Currently (early 2018), we recommend v14.1, which aligns to Android 7.1. Android 8 Oreo is v15, and is likely somewhat experimental at this stage, but read the logs and any forums reports to make up your own mind. At this stage, you can also grab your faux Google Gapps package [Image 5] from opengapps.org — see the boxout below-left for more details on that. Copy both ZIPs to the device — into the Download folder, say — and, no, you don't need to unzip them.



6 WIPE CACHE, FLASH DEVICE, REBOOT

Reboot into TWRP Recovery. Type "adb reboot recovery" if you have a command prompt to hand, or power down, and use the Power and Volume combo. Wipe the Data, Cache, and Dalvik/ART Cache (this is the default), tap 'Wipe' and swipe to go. Not doing this can cause the install to return an error. Return to the main menu and choose 'Install'. Select 'Download' and the LineageOS ZIP. Choose 'Add More Zips' and do the same for Gapps [Image 6]. Swipe to flash, and kiss goodbye to old Android. Once done, do a default wipe again, then reboot into Android. The first boot can take five minutes or so.



7 ENJOY YOUR NEW OS!

Welcome to LineageOS [Image 7]. If you want to use the cloud restore linked to your Google Account, there's an odd quirk at the time of writing. To log on to a wireless network, you need to first choose to not restore from another device/the cloud, set up a wireless connection, then step back, and restore. Otherwise it doesn't set up a connection, making it tricky to download from the cloud.

- Once LineageOS is working, you'll have access to the Google Play Store.

If your Google Account is up and running, apps are slowly restored with some settings in place. Check Security settings, tweak the Notification drawer, and perhaps get a new launcher; Nova Launcher is our favourite.

- We've mentioned root access — this is administrator level access to the Android system. It's generally not required, and considered a security risk, which is why it's off by default, and hard to turn on. If you want root access for backup reasons, Lineage OS makes it reasonably easy.
- Grab the Super User pack for your device's architecture from download.lineageos.org/extras. Copy it to your LineageOS device, reboot into TWRP, and flash the su.zip. Back in LineageOS, enable Developer mode, if you haven't already. You'll see an option called 'Root access' — select 'Apps and ADB mode'. Now apps can be given root access.

Depending on your device, you could find you're getting LineageOS updates once a week. Don't feel you need to install them. You can follow the recent changes update log for your device at download.lineageos.org, along with any changes that will be merged into the next build. ■

The open-source way

Proprietary software is pure evil, so some people say. It denies you ownership of something you've paid money for, hides the true nature of the software, and enables spying, backdoors and security holes to propagate without the user's knowledge. While some of that is still possible with open source, the chances of it happening are much reduced. To try to bring open source to Android, a system was created called F-Droid, available from f-droid.org.

You can install this on standard Android and LineageOS, as long as you enable 'Unknown Source' within the Security settings. Then download and install the APK from the website. F-Droid attempts to be an open-source repository, offering freed software to anyone willing to install it. The quality and range of open-source software available has come on a long way in recent years, and if you're looking for a system tool, or something a little more creative, it's a good place to stop and look for software that at least respects your rights as a user. We're not expecting you to dump the Google Play Store, but F-Droid offers an alternative source of Android software that you can trust.

"F-Droid offers an alternative source of Android software that you can trust."



how to

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

SOFTWARE

REMOVE UNWANTED PHOTO METADATA

What's the quickest way to remove all the metadata from a large collection of photos so I can burn a DVD slideshow?
Trevor Hawker

Metadata (or data that gives information about other data) can be found in a number of different file types including photos. You might want to remove such data for privacy reasons (it may contain personal information, for example). Windows includes a metadata removal tool.

Access removal tool: Browse to a folder using File Explorer, then select all of the files that share the same file type (such as JPG). Right-click them and then choose Properties. Now switch to the Details tab and click 'Remove Properties and Personal Information'.

Remove all metadata: You can also create separate copies of the files with all the metadata removed from them – useful if you're sharing with others or uploading to social media, for example. Simply leave 'Create a copy with all possible properties removed' and click OK.

Selectively remove: Alternatively, you can choose 'Remove the

following properties from this file' if you want to wipe the data from the original files. Click 'Select All' to remove all metadata, or selectively tick the fields that you wish to remove. Click OK to wipe them.

Select from multiple folders: Want to select multiple files of the same type from different folders? Browse to the top-most folder in File Explorer, then type the name of the file type (such as .doc) into the Search box. Hit Enter to quickly generate a list of relevant files.
Nick Peers

IOS

STOP ICLOUD PHOTO LIBRARY FROM STEALING STORAGE

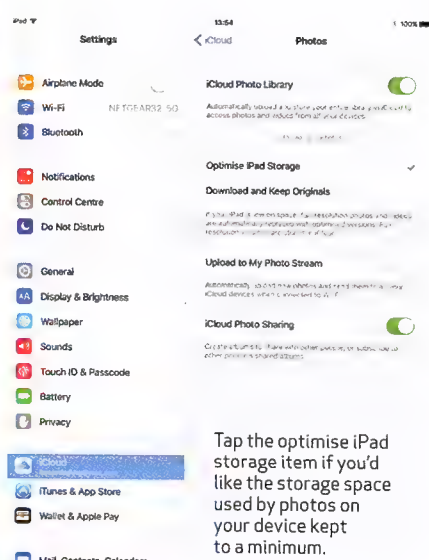
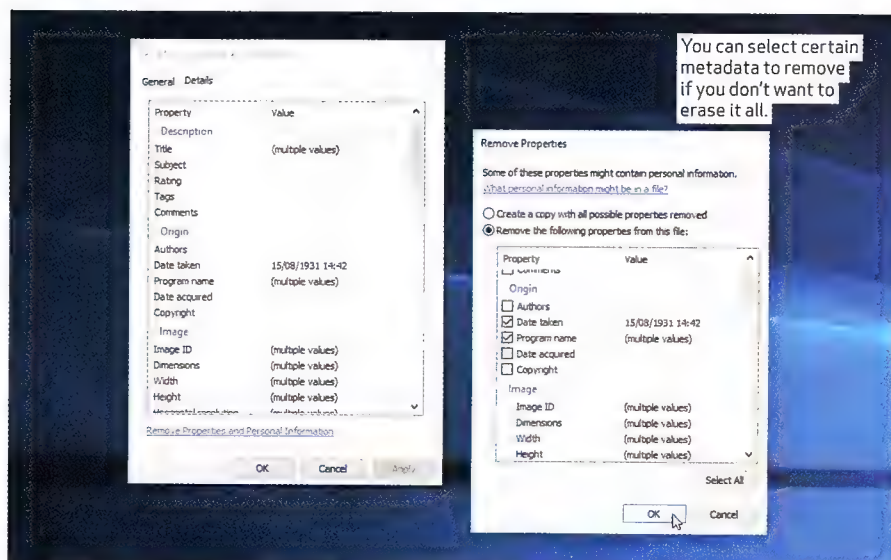
I'd avoided iCloud until recently, when I wanted to show photos from my iPad 2 on a TV. I put them into my iCloud Photo Library using my Mac, and they duly showed up on the iPad. However, they appear in the iPad's Photos app even when the device's Wi-Fi is turned off. I don't want hundreds of pictures cluttering up the device. How can I only collect them from the cloud when I need them?

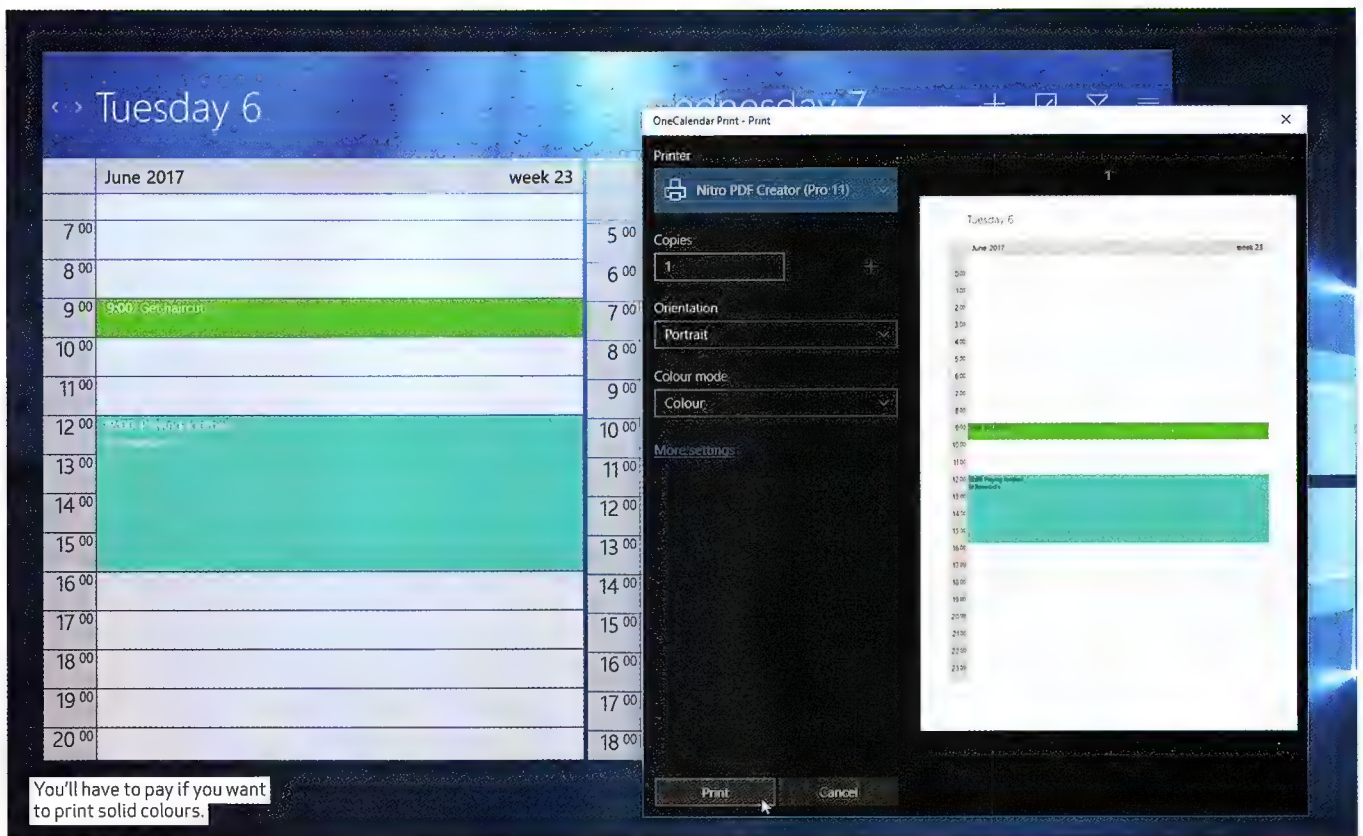
Charles EE

iCloud Photo Library stores all of your pictures in iCloud, but doesn't necessarily lumber all the devices you've connected to your iCloud

account with the whole library. Control its behaviour by going to 'Settings > iCloud > Photos'. When you enable iCloud Photo Library on that page, your iPad will inevitably keep indexes and thumbnail images for your whole library. Below that, though, you have an option of choosing either 'Optimise iPad Storage' or 'Download and Keep Originals'; inevitably, the latter of those uses more storage space, but tap the former and your iPad will manage its use of local storage as efficiently as possible. If your iPad has ample free storage, it may well still keep copies of your most commonly used photos and videos locally on the iPad. However, when the iPad is more pushed for free space, it'll leave the full-size originals in the cloud, downloading them only as needed. You can tell how much local storage iCloud Photo Library is using by going to 'Settings > General > Storage & iCloud Usage > Manage Storage' (under the Storage heading, not iCloud). Scroll down the list to find the total used by Photos & Camera, tap that, and you can confirm how much local space your photo library is using. You could turn on iCloud Photo Library only when you need it, but you'll need to be happy waiting for it to sync each time.

Ian Sleightholm





"On my desktop screen, I see lovely solid colours (as selected) for each event, but when I try to print out a copy of my calendar, all I get is a box and no solid colour."

WINDOWS

CALENDAR DOESN'T PRINT MY WAY

I am using the latest version of Windows 10, but I am having a problem with the Calendar app. On my desktop screen, I see lovely solid colours (as selected) for each event, but when I try to print out a copy of my calendar, all I get is a box and no solid colour. Can you please help?
Tony Lawrence

This sounds like you're referring to the built-in Calendar app, Tony. Sadly, it's very much deliberate behaviour on the part of the app — presumably to save toner and ink and provide clarity. There's no setting to switch this off, so you'll need to hunt for an alternative Calendar app that gives you control over the printout.

Unfortunately, we couldn't find a freebie that offered this level of customisation. eM Client (www.emclient.com) pulls the same trick as Calendar, while Thunderbird (mzl.1a2tbU7j) prints in a different way.

Instead, search the Windows Store for 'One Calendar', which recently added printing support, and which prints using solid colours as you require. You can try it for free, but printing requires upgrading to the Pro version for \$7.45
Nick Odantzis

LINUX

ONE TRUE PATH!

I need to permanently add `/usr/local/xds/bin` to the PATH. Currently, there is an existing PATH in `.bash_profile`, like this:
`PATH=$PATH:$HOME/bin`
`export PATH`
However, I'm not sure exactly where and how to add the extra path.
Dave Pritchard

The PATH variable contains the directories searched for commands when they are given without an explicit path. By default this is only `/bin` and `/usr/bin` for a normal user, the superuser also has `/sbin` and `/usr/sbin` included. You can see the current search path by running:

```
$ echo $PATH
```

The PATH variable contains a list of directories that are separated by colons and you can modify this in the same way as any other environment variable. You may find PATH already contains more than the two default paths, some may have been added in `/etc/profile` while others in your local profile file; `.bash_profile` for the bash shell. Setting a variable replaces the contents with the new information, so it's usual to include the existing path in the assignment in order to add to it. The line in `.bash_profile`:

```
PATH=$PATH:$HOME/bin
```

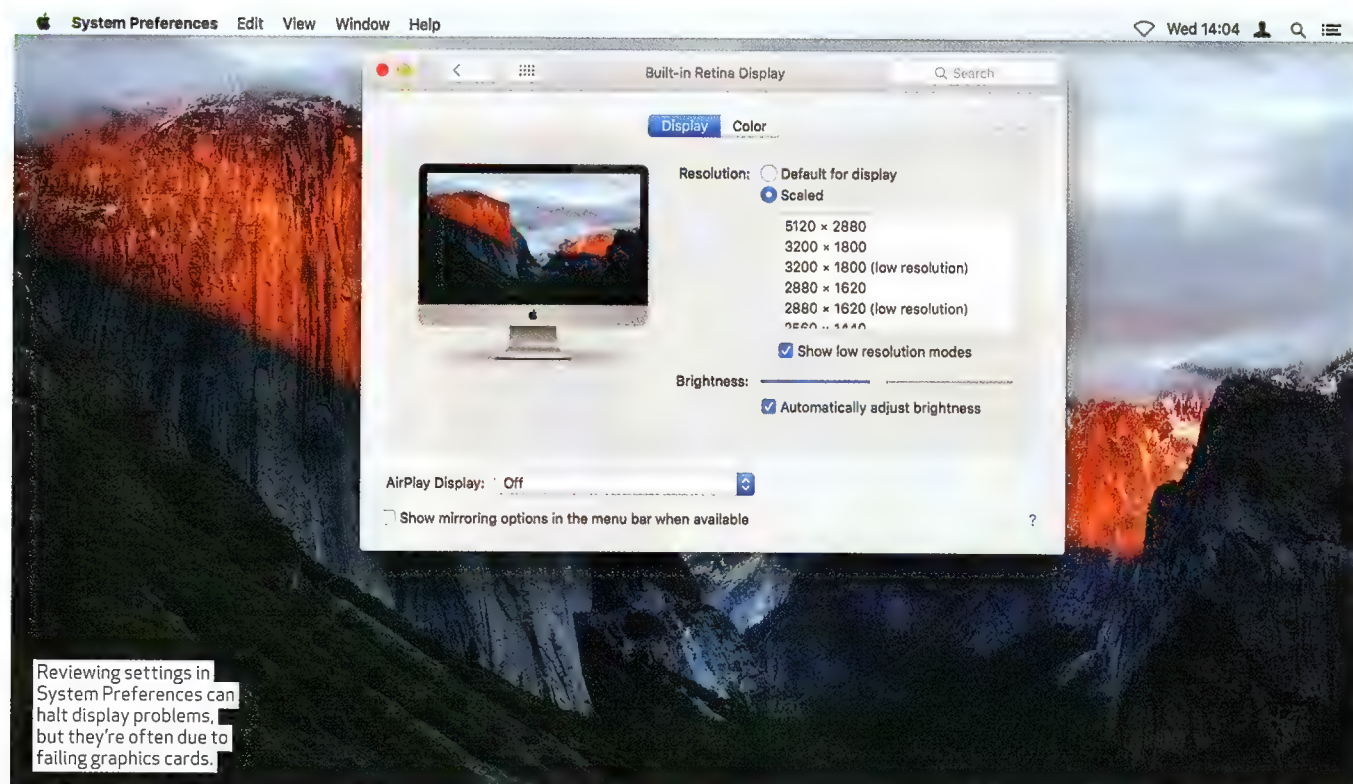
...does just this. The shell expands the original PATH variable first and substitutes its contents in its place. So if PATH previously contained `/usr/bin:/bin`, the actual assignment being run would be:

```
PATH=/usr/bin:/bin:/home/dave/bin
```

See how both the `$PATH` and `$HOME` variables are replaced with their contents. It is normal practice to have a `/bin` directory in your path, where users can store their own scripts. You could modify this line to include the path you want or you could add a separate line to make things clearer:

```
PATH=$PATH:/usr/local/xds/bin.
```

You will need to put this line before the `export PATH` line. The `export` command makes the modified PATH available to the shell and any commands that it runs, otherwise it would be local to `.bash_profile`. Doing this will only add



the path for your user, if you want to make this path available to all system users, you will need to put in either `/etc/profile` or a new file in `/etc/profile.d`. The latter is a better choice if your particular distro uses it as it will not be overwritten by an update, while `/etc/profile` may. The order of the paths is important, the paths are searched from left to right. If the existing `.bash_profile` line reads:

```
PATH=$HOME/bin:$PATH
```

...your `~/bin` directory would be searched first, so if an intruder placed a script in here with the same name as a system command that script would be run first. That's why it's safer to add new paths to the end. If you really want to override the behaviour of an existing command, consider using an alias instead.

APC team

MAC

BLACK SCREEN IMAC LOCKOUT

At seemingly random times, the display of my iMac (21.5-inch, Mid 2011) goes completely black, and the system is then unusable, so I have to perform a forced shutdown using its power button. This iMac has a Radeon HD 6770M graphics card. Why is this happening?

Bob Pringle

Given its vintage, a dying graphics card or other hardware could be to blame. Several models of graphics cards have suffered premature failure, probably because of the introduction of lead-free solder, and some have had their warranties extended as a result.

Before you take the Mac in for repair, check its logs in Console. After this next happens and the Mac has restarted, open Console and search for `BOOTTIME`, which should take you back to the last startup. The entries right before that may give a better idea as to what went wrong at the time of the black screen. Otherwise, run Apple Hardware Test or Diagnostics; if that reports a hardware fault, you'll need to take the Mac for repair. If the hardware checks out OK, the Mac could still have a graphics card problem, which may only be possible to fully diagnose by Apple's in-house tools. The Mac may be inadvertently trying to enter Target Display Mode (as when you press 'Command-@'). You might stop that by temporarily restarting in safe mode, or by checking the settings in the Displays preferences pane.

Ian Sleightholm

SOFTWARE

ARE THESE FILES SAFE FOR ME TO DELETE?

I recently used IObit Uninstaller to uninstall the F-Secure security programs because my free subscription expired. Despite it claiming to have removed everything after running a powerful scan, I've discovered a F-Secure folder remains in Program Files, and it's 489MB in size. Is it safe to right-click and delete this folder?

Lesley Bate

Our instinct is to say yes, but we erred on the side of caution and directed Lesley to the official F-Secure uninstall tool, which you can download

from bit.ly/2tc0sIA. Sure enough, on running this tool, the folder was removed. Lesley also had a follow-up question about whether it was safe to remove seemingly redundant versions of Microsoft Visual C++. This time, however, the recommended advice is to leave well alone – different programs rely on different versions of Visual C++, so removing one may prevent another from working, forcing you to run a repair install to replace the missing version of Visual C++.

Nick Peers

LINUX

MINT PASSWORD RESET

I have acquired a Dell laptop with Linux Mint installed. I tried to update the OS and install software but it asks me for a password, which I don't have. How do I find the password?

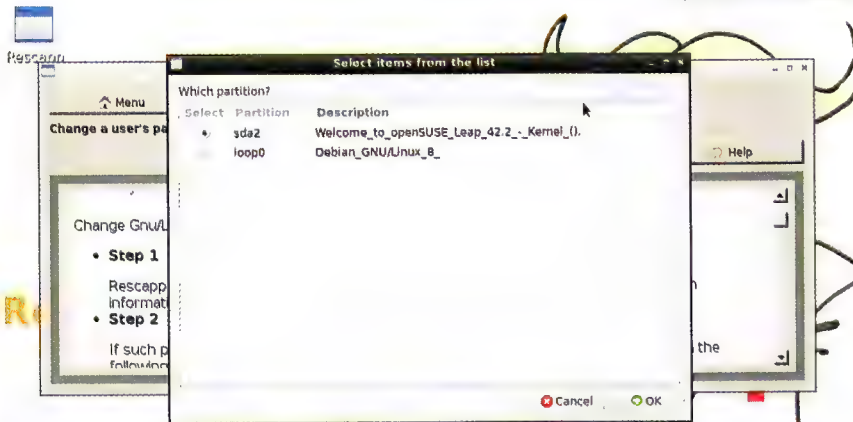
Ed Scott

Linux Mint is a derivative of Ubuntu Linux and uses the 'sudo' command to run programs that need superuser permissions. This means you use your normal user password, the one you use to log in when you boot. However, that piece of advice isn't going to be much help if the computer was set up to automatically login to the desktop when it starts up. If this is the case, you need to boot from a live CD and reset your user password. Most live CDs will do the job, although we prefer System Rescue Cd (system-rescue-cd.org). This boots to a console by default, but that is

<http://www.rescatux.org>

rescapp

tactic
open source & cloud solutions



Debian GNU/Linux 8 (jessie) i386 Build: 2016-09-24 10:03:14
linux: 3.16.36-1+deb8u1 live-build: 5.0~a11-1
live-boot: 4.0.2-1 live-config: 4.0.4-1 live-tools: 4.0.2-1.1

Rescatux
makes it easier
to reset
forgotten Linux
passwords.

fine as the reset process uses console commands. Before you do this, find the device holding your root partition in Mint. You can do this from Mint by opening a terminal and typing `# df`. The 'df' command actually reports free space, but helpfully also includes the device name as the first item on a line; it will be something like `/dev/sda1`. You also need your username, which you can usually see in the menu bar or you can view in the terminal by running `# echo $USER`.

Now boot into the live CD, open a terminal if not already at a console and run:

```
# sudo mkdir -p /mnt/mint
# sudo mount /dev/sda1 /mnt/
mint
# sudo chroot /mnt/mint
```

The first two commands create a directory and mount your Mint disk on

it. The chroot command changes the working environment to that directory. Now you are effectively logged into your Mint system as the root user, so change the password for your user with `# passwd youruser`. It will prompt you for the new password twice. When all is done, press 'Ctrl-D' to exit the chroot, safely unmount the Mint disk with `# sudo umount /mnt/mint` and reboot. This procedure should work with just about any live CD, but if you have the Rescatux rescue disc (www.supergrubdisk.org/rescatux) available, there's a graphical alternative. After booting from the Rescatux CD, you will find a button labelled 'Change Gnu/Linux Password'. Press this, read the instructions then follow the steps to reset the password. Rescatux first scans your disc for suitable distros

then asks you to pick one — there should be only one in your case. Then it lists all the users on that system, your user should be near the end of the list. Make sure you get the right user, then give the new password when prompted.

Whichever method you use, it's advisable to change the password again once you are booted into the system, just to make sure everything is consistent. To do this, simply open a terminal and run `# passwd`. It will ask for your current password, which is why we could not do it this way in the first place and will prompt you for a new one.

APC team

WINDOWS

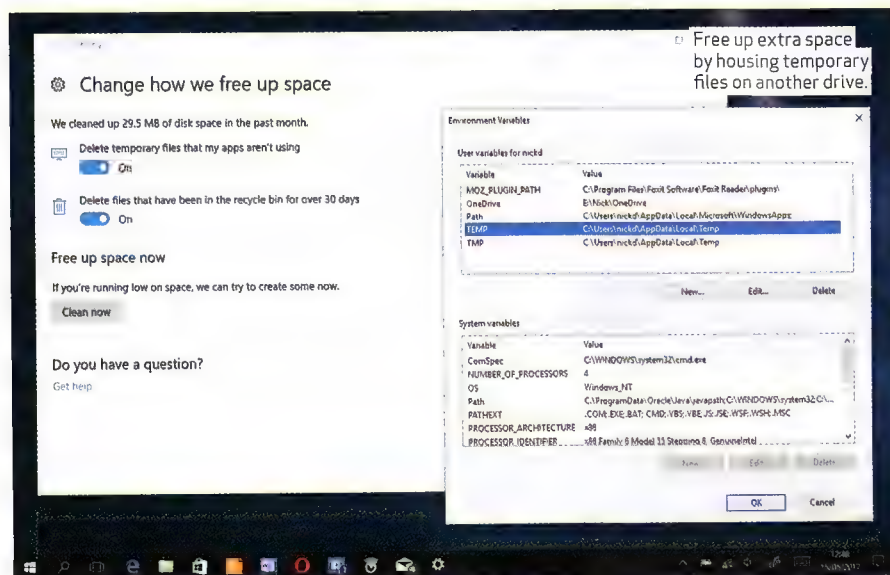
FREE UP SPACE ON A TABLET

I've gone to great lengths to keep my Windows tablet's 32GB SSD drive from filling up, including moving user folders, apps and programs to a secondary drive (the latter using Steam Mover as recommended by yourselves). But I'm still struggling for space — is there anything else I can attempt to shift off the drive to my 64GB microSD card?

Luca Kaestner

Before looking for any additional folders to move, first run Disk Clean-up (or a trusted clean-up tool such as CCleaner) to see if there's any obvious detritus hanging about — for example, if you've recently installed the Creators Update you may be able to free up a significant chunk of space. If you've enabled System Restore on the drive, consider switching it off, but only if you're taking a full drive image using a tool like Macrium Reflect Free. We'll assume any cloud storage (OneDrive, Google Drive, Dropbox and so on) is already saving to your microSD card, but also consider selectively syncing only a subset of the folders available or — in the case of OneDrive — removing the sync completely and relying on the OneDrive Windows Store app to selectively access files directly from the cloud as and when required. If you regularly fill your drive with temporary files, then go to 'Start > Settings > System > Storage' and make sure 'Storage sense' is switched on, clicking 'Change how we free up space' to configure automatic deletion of temporary files and files that have been left in the Recycle bin. Or move the temp files off your drive completely: type "environment" into the Search box and click 'Edit environment variables for your account' before editing both the TEMP and TMP variables, so that they point to your microSD card.

Nick Peers ■

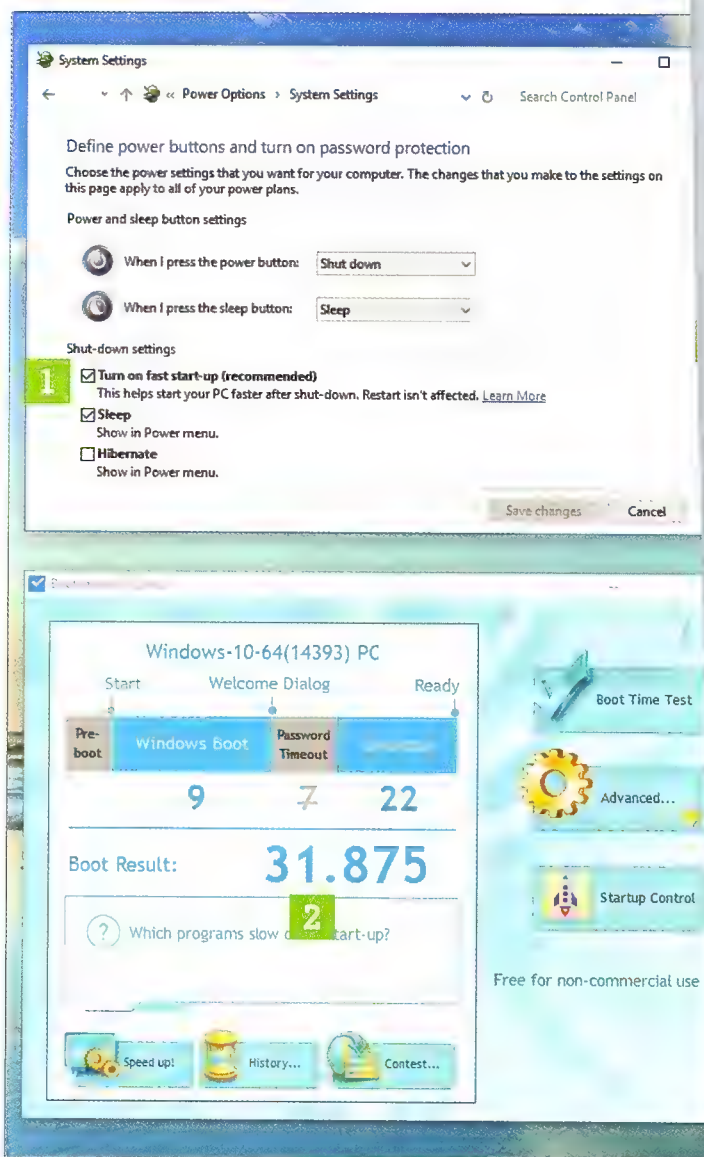


Make Windows boot faster

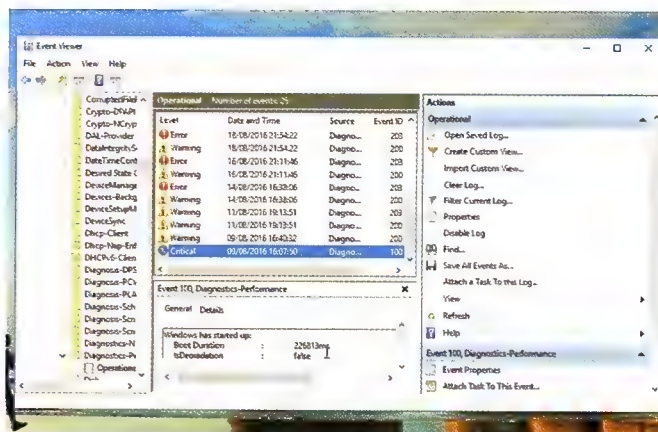
Don't sit around waiting for Windows 10 — Cat Ellis has some tips for making it boot more quickly.

Over time, you might notice that the delay between you pressing your PC's power button and having a responsive desktop is getting longer and longer. It can be enormously frustrating, particularly when you need to get stuck into some important work. You might even be tempted to just leave it switched on all the time, but this means important Windows updates won't be installed. Thankfully, there are ways to speed your PC up again.

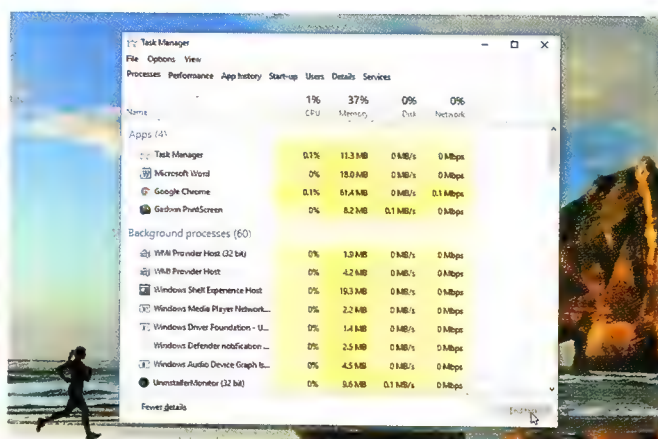
We'll explore several methods here, but it's also worth noting some of the things that won't have an effect — despite claims by the makers of some PC optimisation software. Windows 10 does a good job of managing your hard drive, so defragging it is unlikely to have any effect on performance. Similarly, deleting temporary files, uninstalling programs and tidying the Windows registry won't have a noticeable impact. Here's what will...



Make your PC boot faster



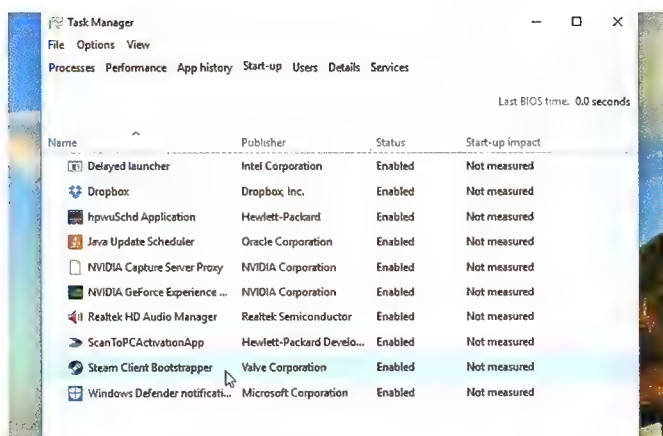
1 FIND YOUR STARTUP TIME
First, type 'Event Viewer' into the Search bar, then navigate to 'Applications and Service Logs > Microsoft > Windows > Diagnostics-Performance'. Right-click the log named Operational, click Open and scroll down the list until you see an event with the ID 100. Click this and look in the small pane below to see the boot duration in milliseconds. Make a note of it — we're going to cut it!



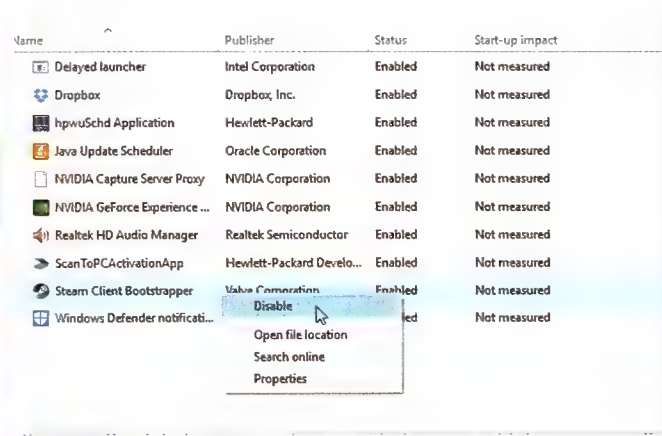
2 USE THE TASK MANAGER
When Windows starts, several other programs start up at the same time. Many are necessary for your PC to work correctly, but others are things you don't necessarily need immediately, and can be started later if you decide you want to use them. To see which programs start at the same time as Windows, you can use the Task Manager. Tap 'Ctrl-Shift-Esc' to see it.



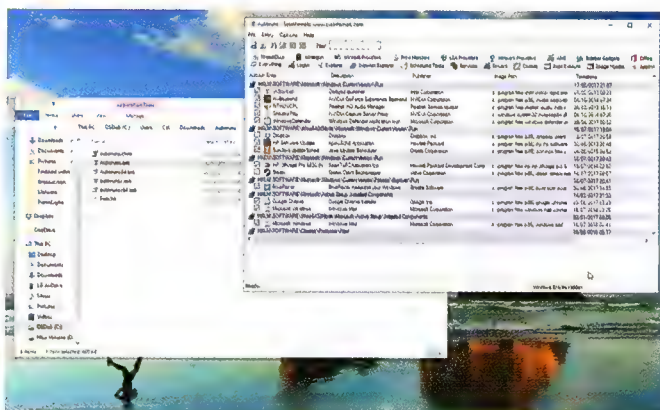
- 1 FAST START-UP**
This is a little like Hibernate mode. It caches your current Windows session so that it can be reloaded quickly.
- 2 BOOT TIME**
You can use Windows' own logs or a program like Bootracer to find out how long it takes Windows to start.
- 3 LOGON**
Selecting this tab will show only the app and programs that run when you log into your Microsoft account.
- 4 ENABLE OR DISABLE**
To stop a program running when Windows starts, just uncheck its tick box. You can always re-enable it later.
- 5 PUBLISHER AND DESCRIPTION**
This will help you work out what each app does, but if you're not certain, leave it alone.
- 6 AUTORUN**
This Microsoft app is the most powerful tool for managing the programs that start at the same time as Windows.



3 CHECK STARTUP PROGRAMS
When the Task Manager opens, you'll see a list of all the apps and processes that are currently running on your PC. Click the Startup tab at the top and take a look through the list of programs that start at the same time as Windows. You'll probably see drivers that relate to your graphics card, printer and other devices, along with other applications you don't recognise.



4 DISABLE UNNECESSARY APPS
What you're looking for are programs that you've installed yourself and don't use every day. Here, there's a program called Steam Client Bootstrapper that launches the Steam game platform. To stop a program like this running every time you start your PC, right-click it and select Disable. If you change your mind later, you can always re-enable it via the Task Manager.



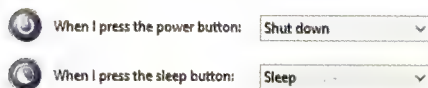
5 GET A CLOSER LOOK

If you know there are other programs starting with Windows, but you can't see them in the Task Manager, you need Autoruns. This little program from Microsoft identifies many more startup programs, including Windows applications. Download it free from bit.ly/1zJKYU, extract the ZIP archive and double-click the file Autoruns.exe.

Define power buttons and turn on password protection

Choose the power settings that you want for your computer. The changes that you make to the settings on this page apply to all of your power plans.

Power and sleep button settings

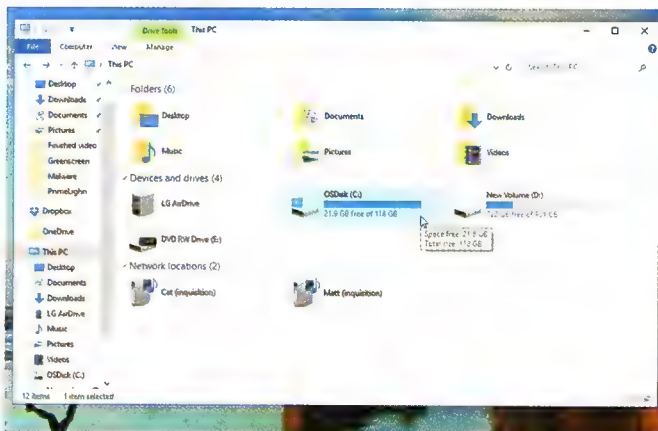


Shut-down settings



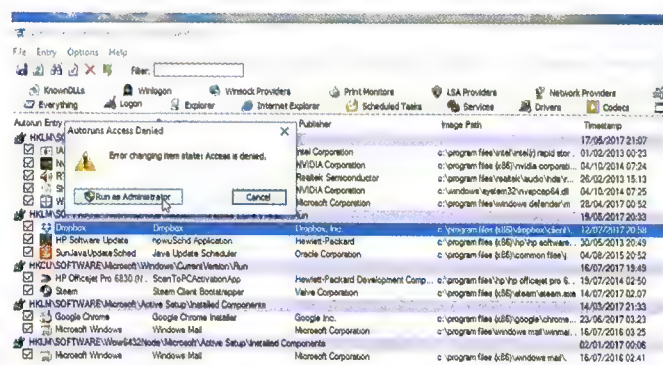
7 ENABLE FAST START-UP

Fast Start-Up is a new tool introduced in the Windows 10 Anniversary Update, and works a little like Hibernate, saving your Windows session in a temporary file that can be loaded quickly when the PC is turned on again. To make sure it's enabled, type 'Power Options' into the Search bar, click 'Choose what the power buttons do' and check the box marked 'Turn on Fast Start-Up'.



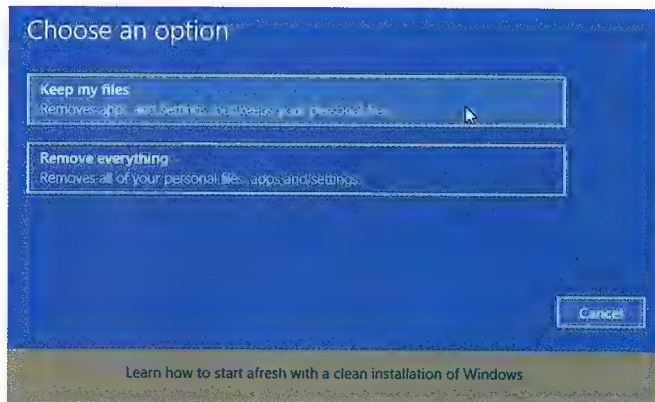
9 UPGRADE TO AN SSD

If you have Windows installed on a hard disk drive, upgrading it to a solid-state drive (SSD) can have a tremendous effect on boot times. You can still keep your files and other programs on the old disk. Unfortunately, you can't just transfer Windows across with a few clicks — you'll need to reinstall it on the new SSD. Microsoft has a handy guide here: bit.ly/2tZkZb3



6 DISABLE AND SAVE

You'll now see a huge list of programs and processes. As before, you're looking for programs you recognise and know you don't need immediately. Click the Logon tab and uncheck the box beside anything you want to disable. You might be prompted to give administrator permission before you can change anything. When you're finished, click Save and close Autoruns.



8 RESET WINDOWS

If your PC is taking several minutes to boot, it's time to reset Windows. Type 'Reset' into the Search bar, select 'Reset this PC' and click 'Get started'. You now have three options: 'Keep My Files', 'Remove Everything' and 'Restore Factory Settings'. Select the first option — it will reinstall Windows and remove any other apps, but will let you keep your files (it's a good idea to back them up first).



10 SEE THE RESULTS

Once you've finished, shut down your PC, power it back on and check your startup time again. Hopefully, you've managed to cut the time significantly! You might want to consider using a third-party app like BootRacer (www.greatis.com/bootracer). This tells you how long the boot process takes, and how long it takes for Windows to be ready to use after you've logged in.

Speed up iCloud and Apple updates

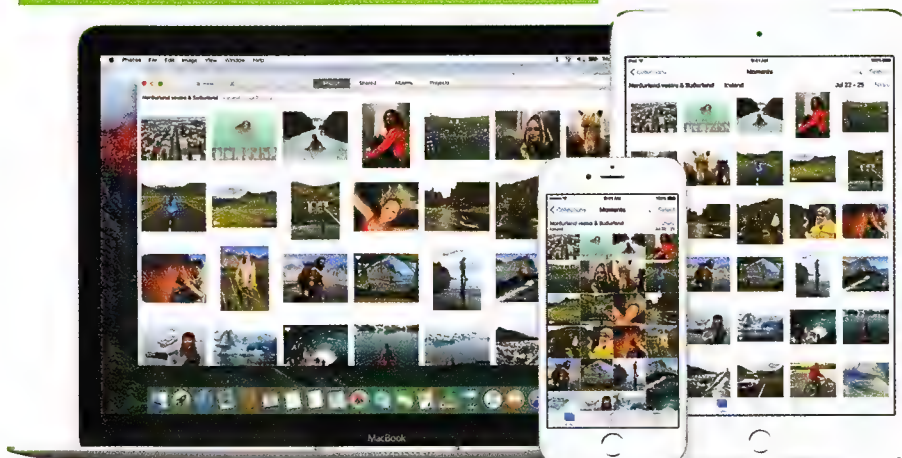
Nick Peers shows how to reduce internet usage with High Sierra's content caching.

Content caching is, to quote Apple, "a macOS service that helps reduce bandwidth and speed up software installation" across all your core Apple devices: Macs, iOS and Apple TV.

Content is stored — or cached — on one of your Macs, and other devices can pull that content quickly from the local network instead of downloading a fresh copy from the internet. By default, all system updates and App and iBooks Store content are cached, plus there's an option to include your iCloud content, too.

Content caching works best on a Mac that's connected to your network via Ethernet rather than Wi-Fi. That Mac

"Content caching works best on a Mac that's connected to your network via Ethernet rather than Wi-Fi."



needs to be switched on and connected to the internet for the feature to work; when it isn't, your devices will pull the data they need from the internet. The step-by-step guide below reveals the basics to enabling, configuring and disabling the feature.

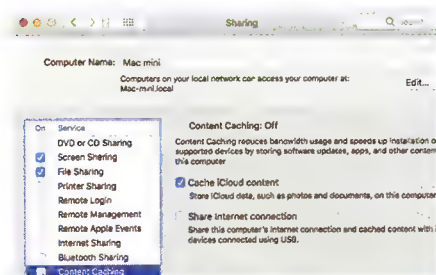
BEYOND THE BASICS

When you embark on setting up the cache, you'll notice there's a 'Share Internet connection' option — this basically extends the cache (and your Mac's internet connection) to any iOS device that's hooked up to the Mac using a USB cable. If your household has lots of Apple devices, and you find one Mac's bandwidth is getting saturated, you can enable content caching on other Macs, too. Devices then intelligently choose which Mac to use to spread the load more evenly.

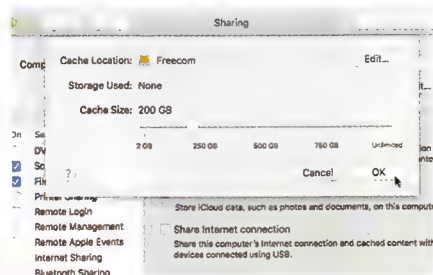
Go to **Apple > System Preferences > Sharing > Content Caching** and hold the Option key: you'll see the Options button change to Advanced Options. Click this and you'll see three more tabs: Clients, Peers and Parents. These allow you to fine-tune your multi-Mac caching setup further. For most people the default settings are fine, but if you're part of a large network, visit bit.ly/contentcaching for a guide to optimising these advanced settings for your needs.

Though content caching is new to the Sharing pane in macOS High Sierra, the feature has been built in to macOS Server (bit.ly/mfmacserv) for a while. Consequently, even fairly old devices that can't be upgraded to High Sierra or iOS 11 will benefit from it, as long as they're running at least iOS 7 or OS X 10.8.2 or later — they'll automatically detect the cache on your network.

How to Set up content caching



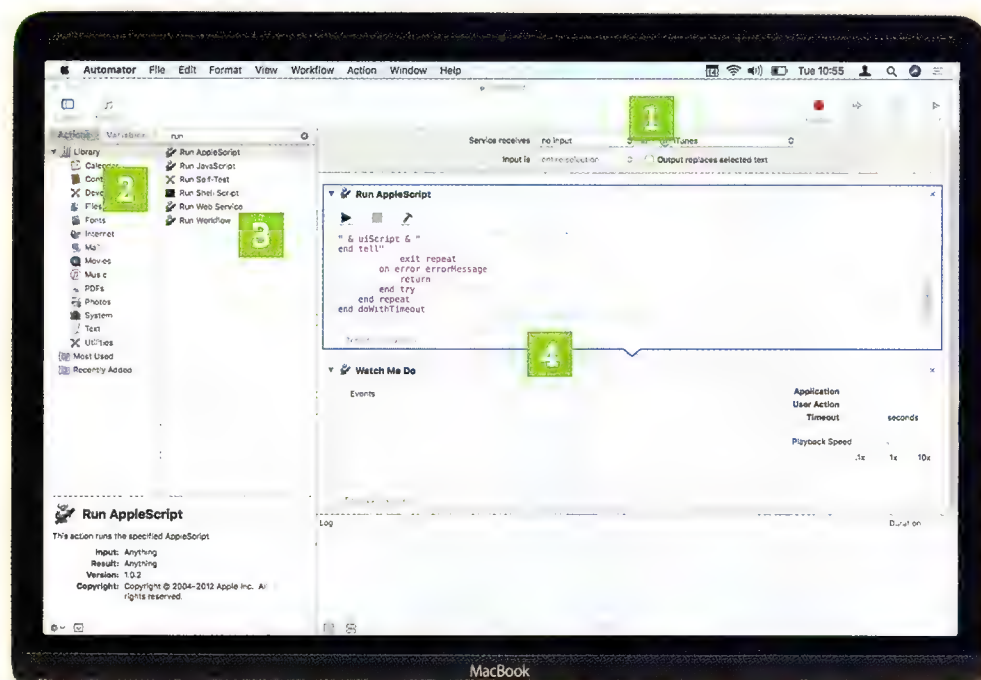
1 CREATE CONTENT CACHE
In System Preferences, click the Sharing icon. Select 'Content Caching' in the list on the left, and tick it to turn it on. Ensure 'Cache iCloud content' is ticked if you want the Mac to store that, as well as media downloads and software updates.



2 SET LOCATION AND SIZE
Click the Options button if you want to store the cache on a different drive than where macOS is installed. By default, the cache size is unlimited; if space is an issue, use the slider to reduce it to a manageable level.



3 CLEAR THE CACHE
Should you ever want to clear the cache, click Options and look for a Reset button — if it's available, click it, then click Reset in the confirmation sheet to delete everything and start afresh. To stop caching, just untick 'Content Caching'.



1 WORKFLOW INPUT & SCOPE

These two pop-up menus tell a workflow what input it will receive and which app it will be used in.

2 LIBRARY

A collection of predefined actions that you can use to quickly build workflows.

3 ACTIONS

The contents of the selected Library section or search results are listed here. Drag and drop actions into the right pane.

4 WORKFLOW

Build your workflow on the right from library items, recorded actions or a mix of both.

Improve iTunes' navigation on Mac

Gary Marshall shows how you can use Apple's powerful built-in automation tool to make it easier to get around.

Automator must envy Siri. While Apple's digital assistant hogs all the headlines, Automator just gets on with the job of automating things on your Mac and gets hardly any credit. It's an incredibly powerful app, and it's nowhere near as frightening as it looks.

Automator's job is to take care of common tasks for you. It's effectively a programming tool, but once you've done the prep work, it can generate the necessary script for you. All you need to do is show Automator what to do and it'll record how to do it.

One of the brilliant things about Automator is that you can use it to add features that Apple hasn't got round to yet. For example, in iTunes, you can navigate much of the interface from the keyboard — switching between kinds of media or moving the focus to the search bar, say — but there aren't shortcuts for the buttons to switch between Library, For You, Browse, Radio and the iTunes Store. As you'll discover, Automator can fix that,

and lets us assign whatever keyboard shortcuts we want.

Automator is all about automation, and Macs are very wary of anything automated in case it's malicious software. That means, if you've got a fairly untouched installation of macOS, Automator might be blocked from controlling your Mac. In that case, your Mac will tell you so when you try to run your Automator workflow, and you may have to give permission to Automator or iTunes in 'System Preferences > Security & Privacy > Privacy'.

ITUNES TRIGGERS

Let's explain what we're going to do in this tutorial. First of all, we're going to record the action of clicking on one of

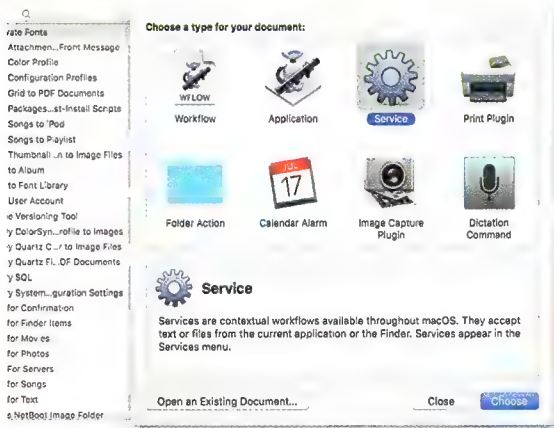
iTunes' buttons, then we're going to turn that recording into the AppleScript for the new Service our keyboard shortcut will trigger. We'll then edit that slightly and copy it for each button, giving us five in total. Then we'll create our shortcuts.

Note that when we edit the AppleScript, we add a 'return' command: that's to prevent error pop-ups if there are fewer than five buttons in the middle of iTunes' navigation bar. We'll make five shortcuts to match the number of sections in the Music category, but other kinds of media have fewer sections, and we don't want pressing shortcut four or five to make our Mac angry.

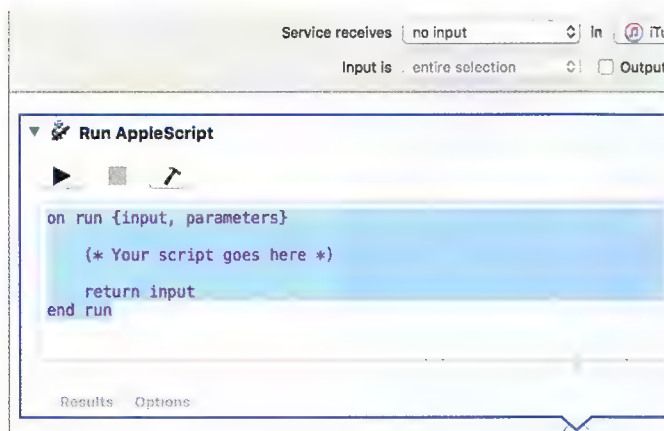
"One of the brilliant things about Automator is that you can use it to add features that Apple hasn't got round to."

How to

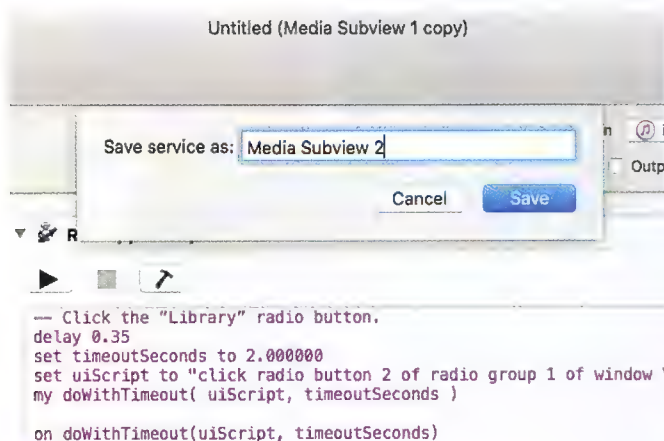
Improve navigation in iTunes



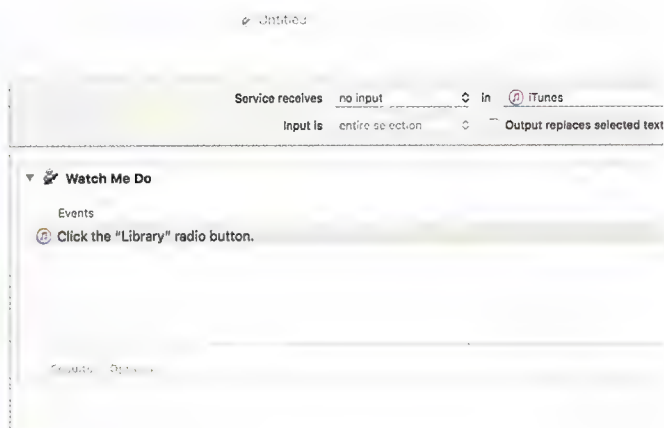
1 START IN AUTOMATOR
Choose 'File > New', create a Service and then set the pop-up menus above the right pane to 'no input' and 'iTunes'. Click Record and press 'Command-Tab' to go to iTunes, then click a navigation link, such as For You. Stop recording.



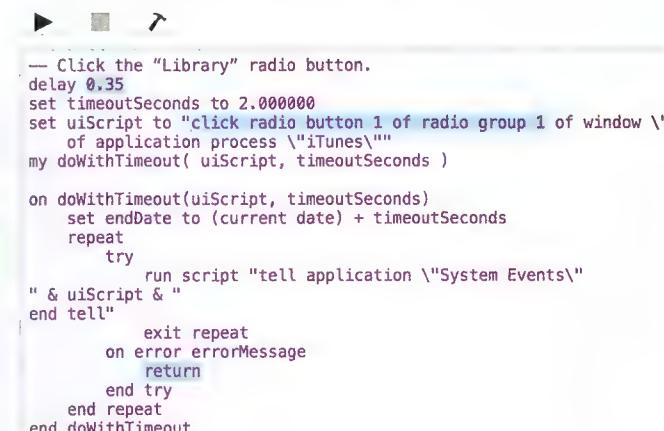
3 ADD APPLESCRIPT
Click Actions (top left), search for 'Run' and drag 'Run AppleScript' into the workflow pane on the right. Select all of the text in the script and press 'Command-V' to replace it with the AppleScript for the action you recorded.



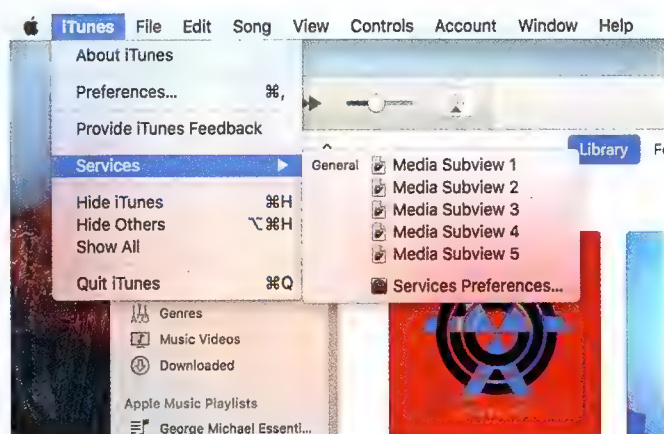
5 SAVE YOUR WORKFLOW
Press 'Command-S' to save your workflow and call it 'Media Subview 1'. Next, press 'Command-Shift-S' to duplicate the workflow, change 'click radio button 1' to 'click radio button 2' and save as 'Media Subview 2'. Repeat for 3, 4 and 5.



2 COPY THE EVENT
Your workflow should contain a 'Watch Me Do' action. In it, you'll see a 'Click the...' event. Select it, press 'Command-C' to copy it, click the action's heading and press 'delete' to delete it. Don't worry, we're going to bring it back again.



4 AMEND THE SCRIPT
Change the number after 'delay' to 0.35 and then replace the text that's between 'click radio button' and 'of radio group' with '1'. Scroll down. Replace everything between 'on error' and 'end try' with the word 'return'.



6 CREATE SHORTCUTS
Open System Preferences and then follow Apple's instructions (bit.ly/mkshrcts) to set up a keyboard shortcut for 'iTunes > Services > Media Subview 1'. We'd recommend 'Command-Shift-1'. Repeat for the other Services you created.

Make an Apple Watch more secure

Prevent prying eyes from gaining access to info on your Watch with David Crookes.

Your Apple Watch stores personal data, so it makes sense to be careful about keeping both the Watch and the information on it as safe as you can. Make sure you use a passcode and set up a way to track your Watch if you do happen to mislay it. There are also some other settings you should pay attention to, such as those related to health and fitness.

In addition, the Watch and your iPhone sync your data, meaning you need to consider the privacy on your phone, too. Since there is always a danger that someone could use your Watch to buy something with Apple Pay without your phone nearby, Watch security is something you should take very seriously. Luckily, protecting your Watch and your data doesn't take long.

"Make sure you use a passcode and set up a way to track your Watch if you do happen to mislay it."

Set up Find My iPhone

If your Watch does not have the Activation Lock activated, then you need to set up Find My iPhone. To do this, go to Settings on your iPhone, tap your name at the top of the screen, select iCloud and scroll down to Find My iPhone. Tap it, make sure the slider next to the feature is green, then enter your Apple ID. Your iPhone, Watch and AirPods will be set up.

More private notifications

By default, your Watch will show short notifications — the name of the app and alert type or sender name — but if you keep your arm raised, these expand to display the contents of the message or email. To keep things more private, open the Apple Watch app on your iPhone, tap Notifications and move the Notification Privacy switch to on. Now when you receive a notification on your Watch, it won't expand; tap it to reply, dismiss or view in the originating app.

Set a passcode for Apple Watch

1 CHANGE YOUR PASSCODE

There's always a chance someone can look over your shoulder as you tap in your passcode, so it's worthwhile changing your passcode every so often.

2 LONGER PASSCODE

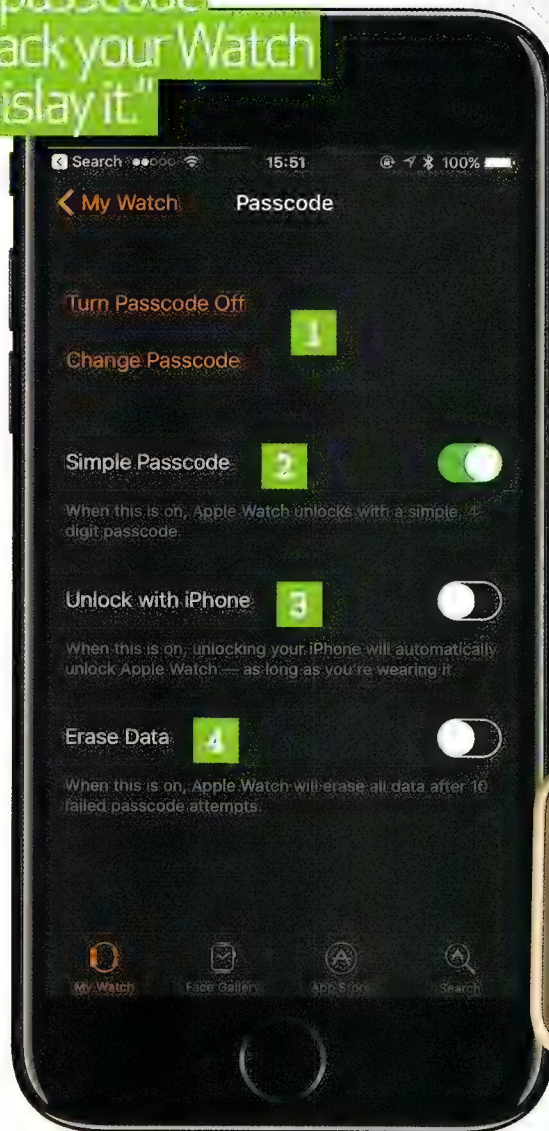
You can use a passcode longer than four digits, but in order to do this, you have to unlock the Watch with your iPhone and input the code on there.

3 UNLOCK WITH IPHONE

For greater convenience, you could have your Watch unlock whenever you unlock your iPhone. If this is something you'd like, then just slide this to green.

4 SET A LIMIT

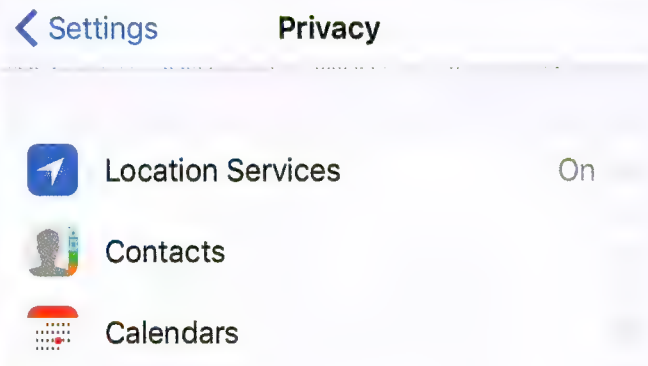
Think about it: if someone stole your Watch, they could try 10,000 times to crack those four digits. Slide this option to green and your Watch will erase all of its data after 10 failed attempts.



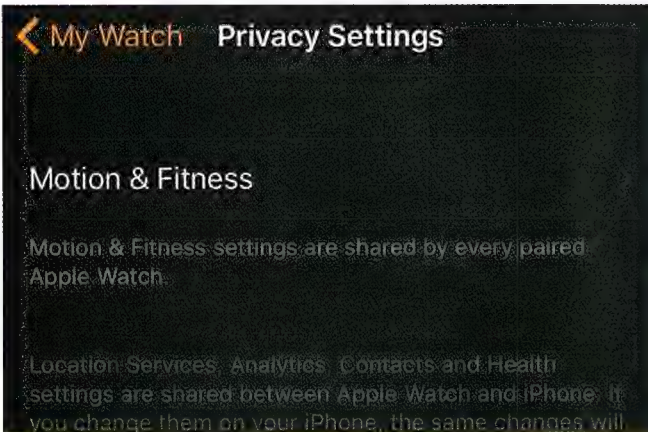
How to

Review your Apple Watch's security

Watch 15:19 100%



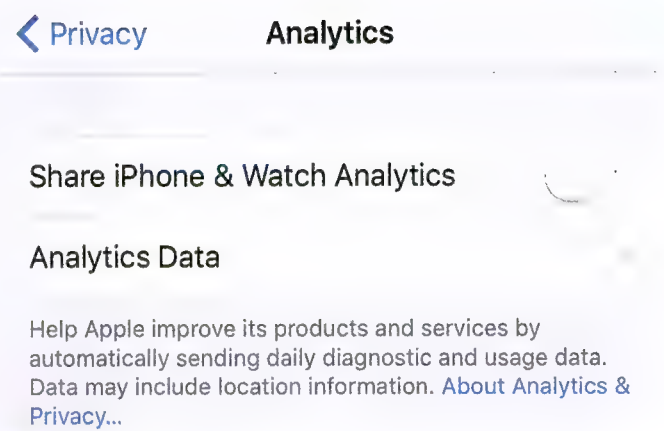
1 CHECK YOUR PRIVACY
Since your Watch will share the health settings, location services, contacts and analytics collected by your iPhone, first make sure you lock all these down. Open Settings on your iPhone and tap Privacy.



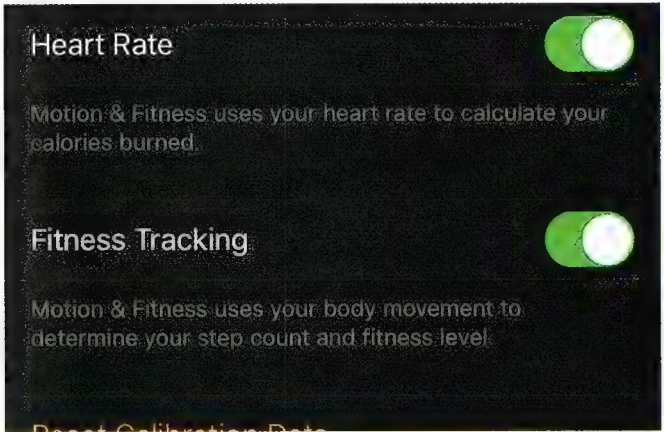
3 TURN OFF FITNESS DATA
Privacy settings can be adjusted to stop your Watch sharing your motion and fitness data. To do this, open the Watch app on your iPhone, then tap 'My Watch > Privacy' and select 'Motion & Fitness'.



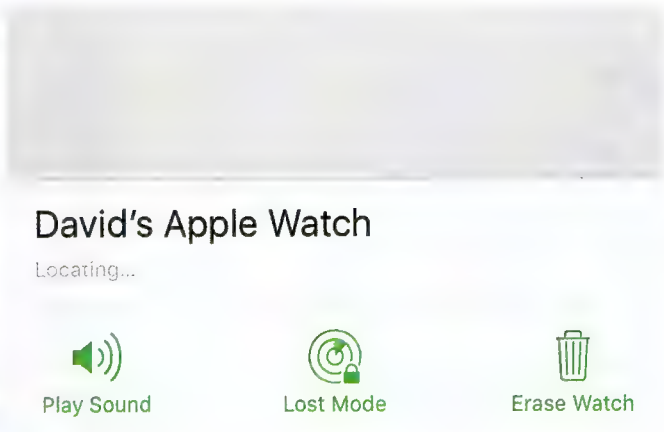
5 CHECK ACTIVATION LOCK
Protect your Watch against theft by ensuring the Activation Lock is on. Tap 'My Watch', select your watch name at the top of the screen and tap 'i'. If you can see 'Find My Apple Watch', the Lock is activated.



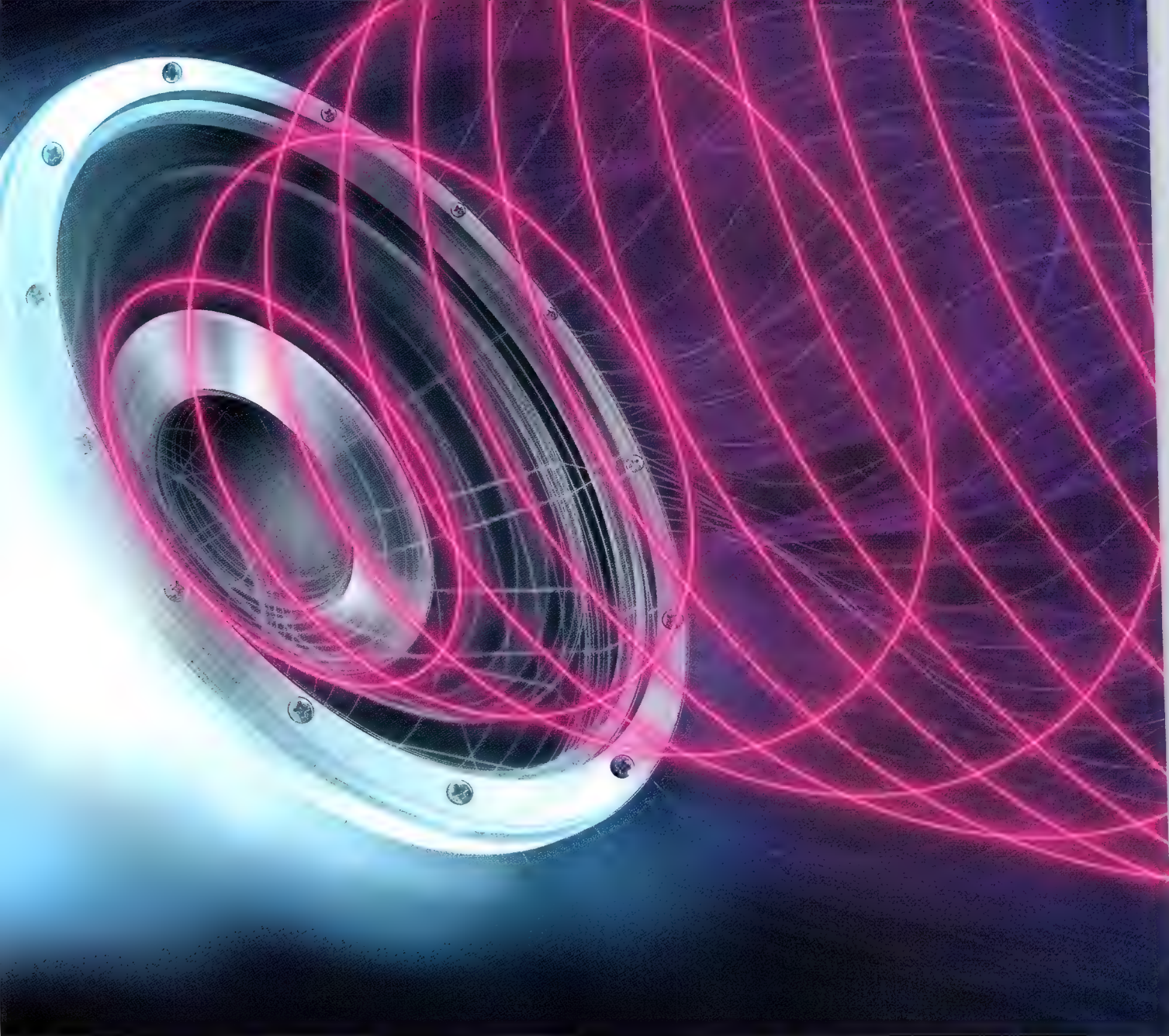
2 ALTER THE SETTINGS
You can turn Location Services off and see which apps request access to your contacts and health data. Under Analytics, you can turn off 'Share iPhone & Watch Analytics'. There's also a 'Share iCloud Analytics' option.



4 MOVE THE SLIDERS
Within 'Motion & Fitness', you'll see two options — one that allows the Watch to monitor your heartrate and another that determines your step and fitness levels. You can turn both of these off.



6 DISABLE THE WATCH
If those words don't appear, see our sidebar for how to set up Find My iPhone. Log in when prompted, and you can locate your Watch on a map, play a sound to help you find it, remotely erase it, or enter Lost Mode.



Pro audio on Linux

The only good system is a sound system. Jonni Bidwell is here to tell you all about Linux's offerings, so listen up!

Sound is a sensitive issue, and as humans, we're very sensitive to audio stimuli. The reason sprinting races are started with a gun and not a flash is because we react much more quickly to sound (about 150ms) than light (about 200ms).

If we're watching a film while our system is busy, then the video and audio may become momentarily desynchronised. In order to restore sync, we could skip (or back up) either audio samples or video frames. Almost universally, media players opt for the latter, since viewers will notice a blip in the audio much more than a couple of dropped frames. We tend to take for granted being able to play high-

quality audio without discerning any distortion, but keeping all those buffers healthy and keeping everything ticking in time with the quartz crystals in the audio hardware is hard work.

Linux often gets a bad rap for multimedia support. Whether it's MP3 playback not working out of the box, video tearing or Blu-rays requiring voodoo number theory and a blessing from the god Ba'al before they play, there are no shortage of gripes. Most of the time, though, this isn't Linux's fault, or even the fault of the hard-working maintainers of kernel driver stacks or multimedia projects. Very often, there are murky patents governing the use of particular

technologies. Then there's hardware that doesn't adhere to standards – and let's not forget that dragon DRM. In fact, Linux has an impressive state-of-the-art multimedia stack, capable of handling not just a 7.1 soundtrack while leisurely streaming 4K video, but also, thanks to JACK, 192kHz studio recording or music production.

Further, the nascent Pipewire project will modernise things yet more, bringing low-latency playback/recording, real-time multimedia processing and support for sandboxed applications.

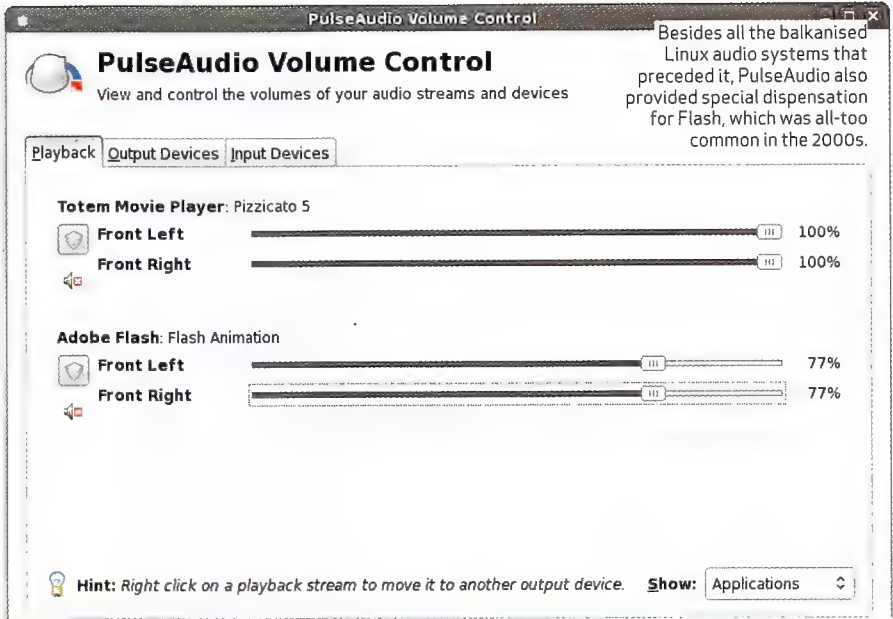
Join us on a journey through the multimedia systems that, for the most part, we no longer need to fight with...

The first audio subsystem for Linux (and other UNIX-like animals), the Open Sound System (OSS), provided basic support for playback and recording, and more than satisfied the audio needs of most '90s bods (we were simpler creatures back then). There was also patchwork support for some devices that was provided directly by the manufacturers (some of them did care about Linux, even in the '90s), but this was generally closed source.

OSS grew out of the drivers for the then-popular Sound Blaster 16 card, which had many clones. It also provided the low-level kernel drivers for audio hardware, as well as an API for applications. As with anything vaguely hardware-related in the early days, getting sound working required recompiling your kernel and optional tears and/or hair loss.

Functionally, OSS provided the /dev/dsp* and /dev/mixer* devices, which generally could only be accessed by one process at a time. This meant that two applications couldn't play sound simultaneously, unless the hardware was capable of mixing the streams natively, and OSS was able to persuade it to do so. To solve this the KDE and Gnome desktops developed their own sound systems, aRTs and ESD, respectively, which did the required mixing in software and despatched the resultant stream to OSS. This worked well, and made writing audio applications much easier, unless of course you still needed direct OSS support, or wanted to support both aRTs and ESD.

And so began the Jenga-like adding of layers to the audio stack. Simple DirectMedia Layer (SDL) is a wrapper around all of the above (as well as input drivers, DirectX/OpenGL and the Windows and Mac sound systems)



Besides all the balkanised Linux audio systems that preceded it, PulseAudio also provided special dispensation for Flash, which was all-too common in the 2000s.

“Open Sound System grew out of the drivers for the Sound Blaster 16 card.”

that's still around today. Its portability makes it especially popular for cross-platform games. But one wrapper is never enough, and so libao was born. Libao had some nice features and eventually found its way into the popular Mplayer project in 2001 in the form of libao2 – the -ao option lives on there as a means to choose which sound system to use.

ALSA IN ACTION

In 2002, OSS developer Hannu Savolainen, then contracted by 4Front Technologies to work on the stack, released OSSv4 under a proprietary

licence (though it was re-released under the GPL five years later and is still developed today). This led to Linux adopting the Advanced Linux Sound Architecture (ALSA, which had been in development since 1998) for the 2.6 Kernel. Many people were happy with this arrangement, although there were criticisms of OSS on Linux besides its newfound proprietary licensing, including its shifting a bunch of signal processing code into the kernel and other gripes lost in the sands of time.

ALSA is a complicated beast and, from the outset, aimed to be much more than OSS. Most notably, ALSA

Loud quiet loud – and repeat

We're all familiar with the "voices too quiet, explosions too loud" problem when watching media at home. Film directors like people to have to listen intently as chiselled jawlines whisper sensitive yet plot-critical information, and they also like viewers to feel like they're in the middle of an explosion, rather than a few blocks away.

This is fine with a THX surround sound system in an acoustically engineered space where these noises can be reproduced accurately. However, your home setup may not be of this fidelity, and even if it was, all kinds of things can still happen to the audio before it hits your speakers. What comes out has likely been resampled (your sound

card may, for example, prefer 48kHz to 44kHz), downmixed (there are many terrible ways of squishing 7.1 channels into two), and treated with any number of other transformations. The audio stream you're playing might not even be that good quality to begin with. Heavy MP3 compression does terrible things to messy waveforms like speech, making it sound dull.

Be that as it may, the main culprit for this annoying issue is the nature of noise itself. Explosions generally are hugely louder than whispers, and making audio equipment that can cope with this volume range is hard. So the solution is to subtly boost the whispery bits and gently attenuate the shouty bits. This is

known as Dynamic Range Compression and you can find an option to activate it in VLC, or with mpv, use the option `af=acompressor`.

wanted to treat hardware uniformly with thread-safe kernel drivers, provide software mixing where necessary (to accommodate onboard audio codecs, such as the ubiquitous AC97, which offloaded mixing duties to the CPU) and improve MIDI support. But it also wanted to be compatible with OSSv3, so an emulation layer was required.

So ALSA consisted of a kernel component, which provided the hardware drivers, together with a userland library exposing the native and OSS userspace APIs as well as the mixing component. ALSA's own low-level API is pretty beastly, which had consequences we'll discuss later. There were also plugins for up/down-mixing, equalisation, resampling and interacting with all the other audio systems.

Setting up software mixing was a bit of a mission in the early days, and whether it worked depended on your hardware and the phase of the moon.

You'd have to create a configuration file `~/asoundrc`, call the "dmix" plugin to arms, and then spend a day listening to two applications fight it out. Often, you'd give up and decide you didn't really need to hear the ding of an AOL instant message if it was going to interrupt your 128k Metallica MP3.

This functionality was actually disabled by default initially, so casual desktop users still relied on ESD and aRTs. Those and other systems then had to add support for ALSA, or use its OSS emulation layer. So much for progress. However, things improved, bugs were found and fixed, and mixing support was enabled by default in major distributions. Professional musicians were able to use the JACK Audio Connection Kit (JACK, started in 2001) and real-time kernel patches to seamlessly route audio between applications. All of a sudden, Linux became a serious platform for music production.

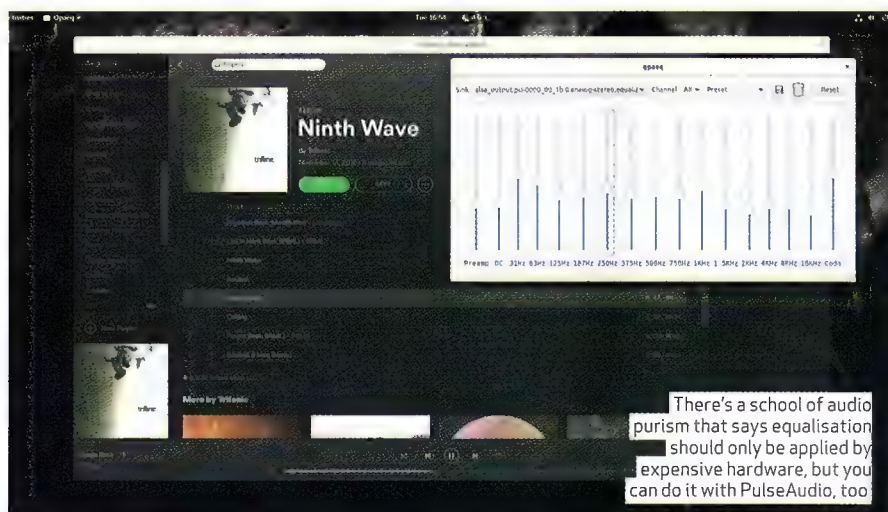
NOT A PERFECT SOLUTION

But on the desktop, some gripes remained. ALSA's dmix implementation was a little hacky. It didn't really enable multiple streams to access the hardware at the same time; rather, it allowed whoever got there first to share their access. In most cases, this amounted to almost the same thing, but things broke down when, for example, multiple users tried to play things simultaneously.

There was also only a single software volume control, so lacked per-application volume control. In some cases, this could be worked around, but for others, especially playing network audio, the shortcomings became apparent. Windows Vista, for all its resource-sapping widgets and abundant other flaws, did feature a whole new audio stack. Apple, likewise, had its CoreAudio stack, which like so many Apple things was simply magical.

Enter PulseAudio. It is perhaps a measure of how popular Linux (or perhaps just Ubuntu Linux) had become that PulseAudio drew so much criticism when it went mainstream. It started life as Polypaudio in 2004 and, four years later, found its way into Ubuntu 8.04. Intentions were honourable, but unfortunately things did not go so smoothly — see the original ambitiously titled mission statement at bit.ly/audio-mess.

PulseAudio is a sound server that sits on top of ALSA. It doesn't touch the kernel at all, and aimed to replace middle layers such as aRTs and ESD while, at the same time, maintaining compatibility for them. It provided exciting new features such as network audio, timer-based (as opposed to interrupt) scheduling, on-the-fly switching of inputs and outputs, as well as per-stream volume controls.



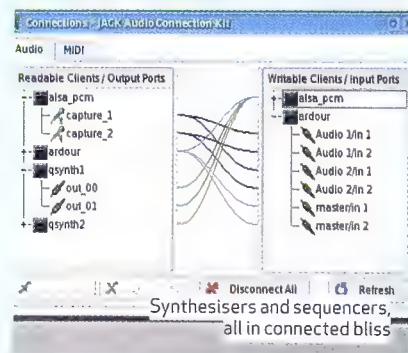
JACK of audio trades

JACK (aka JACK Audio Connection Kit) has been serving hardcore Linux audiophiles since 2002. As its delightful recursive acronym (*What happened to those?* — Ed) suggests, it enables apps to plug into one another and for audio to be routed hither and yon, and in real-time, too.

Like PulseAudio, JACK is a sound server that sits on top of ALSA (and many other hardware backends on many other platforms). It requires exclusive access to hardware, so can't be used at the same time as PulseAudio, but that doesn't mean the two can't live side by side, cordially if not amicably. PulseAudio can be temporarily disabled, or routed through JACK while it's in use, so there's

no need to uninstall it to try out JACK. Nor should you consider replacing PulseAudio with JACK: they do have a common feature set, but PulseAudio is generally what you need for desktop audio purposes.

JACK is what you want if you're running digital-audio workstation software (such as Ardour), software synthesisers (such as Bristol), drum machines (such as Hydrogen), or any combination of these and other audio software. This kind of work used to require a patched real-time kernel, but real-time scheduling is now supported in the mainline kernel, so low latencies can be had with minimal fuss. The original JACK, written in C, has been



reimplemented in C++ as JACK2 (aka jackdmp). See the JACK website at www.jackaudio.org for more details about the program.

This brought parity with the recently released Windows 7.

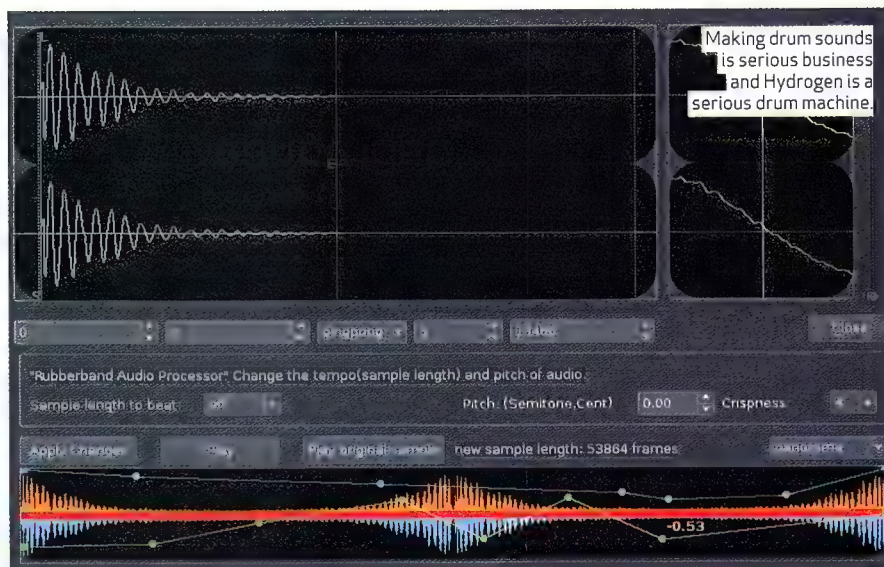
The problem was, most Ubuntu users didn't need (or didn't think they needed) these features, and the previous ALSA/ESD arrangement worked perfectly well for them. Suddenly, PulseAudio was on their systems and audio was stuttering, distorting or going out of sync during video playback, while certain applications no longer worked at all. Forums became awash with disgruntled users wanting to banish this audio heathen. Also disgruntled users who had broken their systems by uninstalling PulseAudio without due care and attention, taking with it all the applications that depended on it, of which there were many. Complaints about PulseAudio not working began to outnumber those concerning wireless.

There were certainly some bugs in the version of PulseAudio shipped with 8.04, but it's not fair to plant all the blame there. There were more bugs in the Ubuntu implementation. But more interestingly, the mass adoption uncovered bugs in that sprawling ALSA API we mentioned earlier. So complex was this beast that much of its functionality remained unused (and largely undocumented) until PulseAudio, and suddenly, here was all manner of hardware and applications hitting these hitherto unused features. These have all been fixed and anyone that's ever used HDMI audio should be grateful: without PulseAudio's advanced routing functionality, this would be much harder. The latest PulseAudio release, 11, adds support for various Airplay and Bluetooth devices, and even includes support for GNU/Hurd.

It's still possible to run a pure ALSA configuration. This provides lower latencies and would be suitable on a constrained device where only a single audio application is installed, for example, an old Raspberry Pi running MPD (although if you care about sound quality, you really should add a DAC to it — sound quality through the Pi's headphone jack is weak). PulseAudio is included in all major desktop distributions and by now is definitely at the 'just works' stage for most desktop hardware. The only reason to avoid it is for professional audio work, where sub-10ms latencies are required. There's really only one solution here (OK, technically two) so check the box (on the opposite page) if you don't know JACK.

TOTALLY WIRED

The latest development in the Linux multimedia sphere is the Gstreamer man Wim Taymans' PipeWire. This ambitious project was originally titled PulseVideo, and yes, it aims to do for



"PulseAudio is definitely at the 'just works' stage for most desktop hardware."

video what PulseAudio does for audio. We don't mean that PipeWire makes you want to uninstall it by any means necessary and revert your video playing subsystems back to how they were, all the while cursing your distro for adopting this "rubbish". PipeWire hopes to reduce fragmentation and simplify existing frameworks for media playback.

PipeWire also wants to go further than Pulse, in the sense of supporting the professional audio use case that currently involves switching to JACK. It's worth noting that PipeWire isn't about replacing these systems, though, but rather re-implementing them as components of a bigger framework. By routing video and audio streams through the same daemon, the work currently done by other frameworks (like Gstreamer and KDE Plasma's Phonon) would be greatly reduced. Video streams and soundtracks become much easier to sync as there will no longer be two different (and highly time-sensitive) processes negotiating things. Codecs can be managed from a single place so there will be no more situations where a file will play in one application but not in another.

PipeWire also wants to ease the transition toward Wayland and containerised applications (those packaged as Flatpaks, Snaps, Appimages). Anyone who's dabbled with Wayland will be aware that it currently struggles with things like screenshots and screen recording (a shortcoming that also affects remote desktop software).

The reason why these don't work is because Wayland isolates applications in the same way as Flatpaks and the rest do, preventing them from seeing what other applications are up to (including what the compositor is putting on the screen). By adding support for PipeWire in the compositor, this could be solved in a secure manner. Likewise, adding support in the SPICE protocol will benefit multimedia applications running in VMs.

You can read more at Christian Schaller's blogpost at bit.ly/launching-pipewire. You can experiment with PipeWire in the recently released Fedora 27, too. Incidentally, this release allows hitherto verboten audio formats such as MP3, AAC and AC3 to be played without the use of third-party repositories. In a world of streaming media and awesome open formats like FLAC and Ogg Vorbis, this is perhaps less relevant than it once was, but better late than never. ■

Play videos from the Linux terminal

John Knight attempts to woo scared multimedia users into trying the terminal with MPlayer's amazing capabilities.

MPlayer has a GUI, so why on earth would you use it via command line? Simple: combining MPlayer with the terminal gives you power in ways a GUI program just can't. So much like your mum explaining why you need to eat your vegetables (until you eventually relent!), here's to doing things the hard way.

Using MPlayer without any fancy tweaks or options is easy. The command with all defaults simply looks like this:

```
# mplayer thisisanexample.avi
```

If you've not used MPlayer before, you need to realise that MPlayer is entirely keyboard-driven. Initially, this seems odd, but there's method to the madness: flicking through videos is much faster than a regular mouse-driven GUI, and if you know your place in the movie, you can make a few button taps to get within a few seconds of where you want to be.

To get started, 'F' is for Fullscreen, 'Space' is for pause, 'Q' is for quit, and the arrow keys fast forward and rewind in intervals of either one minute (Up and Down), or ten seconds (Left and Right). 'Page Up' and 'Page Down' seek in ten-minute intervals, while volume is controlled by the '*' and '/' keys on your keypad. And that's about all you need to get going.

MPlayer's keyboard-driven interface feels weird at first, but its whole setup and aesthetic leaves you feeling like



you're on some kind of tactile, bespoke machine — like a video production station or a security monitor, rather than just using another generic video application on a dull PC. Navigating videos this way is immensely satisfying and extremely fast.

At this point, it's worth introducing the 'O' button, which enables the On Screen Display (or OSD for short) with that perfect machine font that looks like something from a '90s

Betamax studio player — further reinforcing that feeling of using a proper custom machine. Pressing 'O' once will enable certain OSD elements, such as a progress bar that activates when you seek. A second press will bring up a simple timer, a third will show the timer against the whole length of the track, and a fourth press will turn the OSD back off again.

Let's look at some other kinds of media while we further examine the controls. Playing DVDs is a doddle — though perhaps an odd one. Without menus, you need to manually wade through the DVD title numbers in search of what you want. Starting with title 1, the command simply looks like this:

```
# mplayer dvd://1
```

Trying each title individually sounds worse than it is: a movie will usually be placed on either title 1 or title 2, so try title 2 instead if you just get an annoying warning screen. Extra features will generally be stored in the higher numbers.

This might sound like more effort than it's worth, but if you think about all the menus and warning screens you usually need to wade through on a DVD, the MPlayer way usually has you

MPlayer quick command guide

Space.....Play/Pause
Up arrow.....Fast Forward 1 minute
Down Arrow.....Rewind 1 Minute
Right Arrow.....Fast Forward 10 seconds
Down Arrow.....Rewind 10 seconds
Page Up.....Fast Forward 10 Minutes
Page Down.....Rewind 10 minutes

Play a DVD:

```
# mplayer dvd://1
```

Play a CD:

```
# mplayer cdda://
```

V.....Subtitle Visibility
1 & 2.....Contrast
3 & 4.....Brightness
5 & 6.....Hue
7 & 8.....Saturation
9 & 0.....Secondary volume controls
F.....Fullscreen
Enter.....Close current file
Q.....Quit MPlayer entirely
O.....On Screen Display
V.....Subtitle Visibility
*.....Volume Up
/.....Volume Down

Cool stuff we couldn't fit in!

MPlayer can be a 'bathtub of code' sometimes, but it has some brilliantly quirky abilities. On the more conservative side, its `-zoom` and `-loop` options make MPlayer ideal for advertising displays and art installations (perhaps particularly effective when coupled with a Raspberry Pi?).

Here is a video being upscaled and left on a permanent loop:

```
# mplayer test.avi -zoom -xy 1600 -loop 0
```

For something quirky, it's a cliché now, but you can output your videos into ASCII. It's cheating a bit, but if you want things to look like *The Matrix*, you can change the video output to 'matrixview' with the `-vo` switch, like so:

```
# mplayer -vo matrixview test.avi
```

However, that's not really ASCII, it's a video filter! For true ASCII video (handy if you're running without X), try the 'caca' video output:

```
# mplayer -vo caca test.avi
```

Speaking of the terminal, if you're very lucky, you might be able to use framebuffer support to play video in your terminal without X. Try this first:

```
# mplayer -vo fbdev test.avi
```

But don't despair if that doesn't immediately work, as the output modes `fbdev2` and `directfb` may run instead. Otherwise, check out this excellent howto on running video in the Linux console by Dan on TechieStuffs: tinyurl.com/yc4yudkn

into the movie within a few seconds (and is it really that much labour trying a 2 if 1 doesn't work?). And it's a great way to quickly find any Easter eggs!

Once it's playing, you can tweak your movie on the fly with some impressive video controls. Keys 1 and 2 adjust contrast, 3 and 4 the brightness, 5 and 6 the hue, and 7 and 8 control colour saturation. And in case you're watching a foreign film or need captions, 'V' turns on the subtitle visibility, and 'J' cycles through the available languages.

Strict console users without 'X' will be pleased to know MPlayer also works as a CD player, and is easy to use as well – seeking with the arrow keys is a great way to navigate a CD. To play a CD from the start, simply enter:

```
# mplayer cdda://
```

To specify a track, just add the track number to the end of the command:

```
# mplayer cdda://6
```

NITTY GRITTY

That's all well and good, but how is this any more useful than a GUI? Well, MPlayer comes into its own when it interacts with the Linux shell in general: pipes, scripting, info dumps, that sort of thing.

Let's start with something basic. Say you want to play all the video files in a folder. That's as simple as entering:

```
# mplayer *
```

If you have just run this command, the Enter key will close the current video should you want to move on to the next one.

Perhaps you have an enormous library of movies or music videos and are in search of one video in particular, but all you can remember is the first letter (let's say it starts with a 'W' for this example). Remembering that Linux is case-sensitive, you could play all videos starting with W in either case by entering:

```
# mplayer W* w*
```

If you collect and store music videos offline, you probably have an enormous folder full of randomly named film

clips. If you want to jump straight to some videos of a particular band without having to sort through hundreds of files, the terminal is very helpful.

Let's say you want to play all locally stored videos from the band Audioslave. You have no idea whether files will start with upper or lower case, and there is a decent chance files may not even start with the band's name (perhaps starting with some numbers, for instance). You can get around this by simply searching for the middle of the word, and placing an asterisk on either side. By forgetting the A at the start, this command will now play any Audioslave videos, regardless of how the filename starts or ends:

```
# mplayer *udioslave*
```

GETTING ELABORATE

Of course, a terminal column wouldn't be a terminal column without a good old pipe, and MPlayer is no exception! For the uninitiated, pipes allow you to connect one program – or even many – to another in a chained sequence, connecting one program's output to the next program's input.

Of course, MPlayer can stream a file directly from its URL, but we wish to demonstrate its pipeable functionality. So we've chosen a simple example, piping the output of download program `wget` to the input of MPlayer. The syntax is slightly baffling: the `-0` switch obviously means 'output',

but those phantom hyphens are a bit odd! Either way, here we are streaming a public test clip from the Cinelerra website, showing some footage from Italian television:

```
# wget https://cinelerra-cv.org/footage/rasseгна2.avi -0 - | mplayer -
```

MPlayer is also handy for dumping the file you want to stream to something stored locally. We'll forget the pipe for a moment and just stream the file directly, but here we are 'dumping' the Cinelerra test video to a stored local file:

```
# mplayer https://cinelerra-cv.org/footage/rasseгна2.avi -dumpstream -dumpfile dumped.avi
```

Note the URL comes immediately after the command; the `-dumpstream` and `-dumpfile` switches tell MPlayer that this is a streaming internet file to be saved locally; and finally the filename is specified for where you wish to 'dump' it. This functionality is particularly useful for old streaming content from the late '90s and 2000s (particularly archived radio programmes), and it's worth noting the documentation uses the old .asf file format as an example! So yes, MPlayer has a slightly odd way of doing things, and you're still likely to prefer a GUI program. But hopefully we've shown you some things you didn't know the terminal was capable of, and perhaps it hasn't been so hard after all? ■





WHAT'S THE NEXT
MUST-HAVE
ON YOUR GADGET WISHLIST?

WAIT NO MORE. GRAB THAT LATEST TECH WITH GREATEST SAVINGS.
WWW.GETPRICE.COM.AU

GETPRICE 

Secure your Google account

Nick Peers shows how to perform a security audit and use simple tips and techniques to keep your personal data safe and secure online.

Almost every other day brings news of yet another online security hack. The vulnerability of our personal data has never been more apparent, but there's no reason to sit there feeling helpless or to retreat from the internet completely. Armed with the right tips and techniques, you can tighten your online security to make

it much harder for hackers to gain access to your online accounts or personal information.

In this tutorial, we're focusing on your Google account, but many of the steps will work with your other online accounts, too. Most of us have connected to Google at some point, whether it's to collect email in Gmail, sync web browser settings in Chrome,

purchase books, media or apps on Google Play or back up data to the cloud using Google Drive.

Read on to discover how to perform a much-needed security audit and to tighten protection, such as using strong passwords and two-step verification.

How to audit and secure your Google account



Sign in

Use your Google Account

Email or phone

yourname@gmail.com

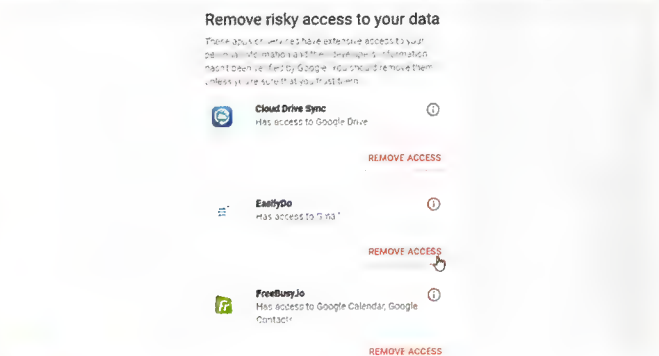
Forgot email?

More options

NEXT

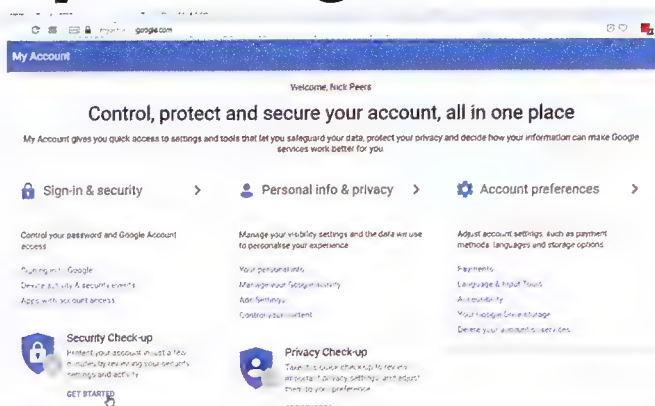
1 LOG INTO YOUR ACCOUNT

After performing manual scans with your security software, open your web browser and head over to <https://account.google.com> to log into your Google account. If you get a cookie mismatch error, open your browser's privacy and security settings and add 'google.com' to the list of allowed exceptions, then try again. Enter your username and password to log on.



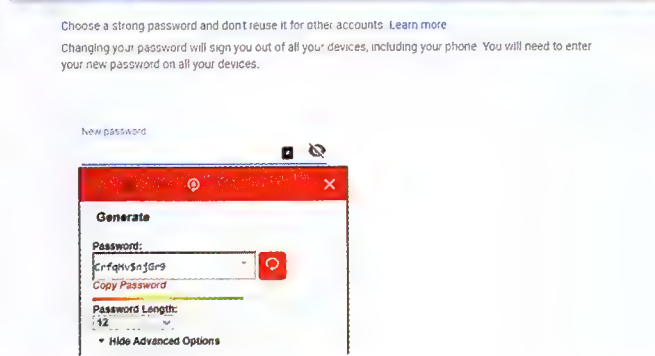
2 REVIEW AND REVOKE

Work through the sections using the annotation as a guide. It's all self-explanatory — potential security issues, such as risky apps are listed first, but don't forget to check everything within each section (click 'Show others' under 'Third-Party Access', for example). Revoke access where applicable, or click 'Don't recognise an event?' to change your password.



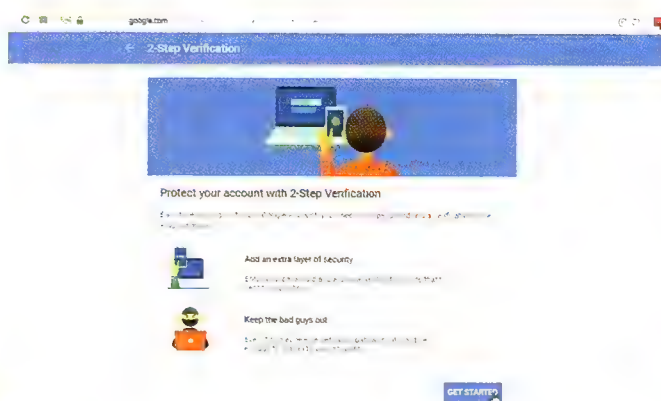
3 PERFORM A SECURITY AUDIT

You'll see your account settings are split into three sections — let's start with 'Sign-in & security'. Scroll down the page and click 'Get Started' under 'Security Check-up'. You'll be given an instant security rating, with potential issues split into four categories. Start at the top by clicking 'Third-Party Access' to see which apps and services have unverified access to your account.



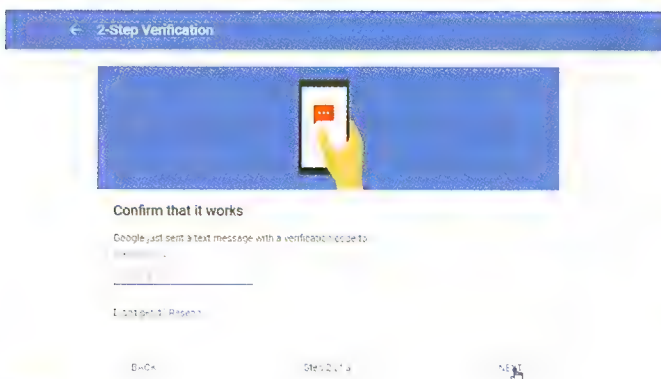
4 CHANGE YOUR PASSWORD

When you've completed your audit, click 'Continue to my account'. From the main screen, click 'Signing into Google'. You'll see your password listed along with the date it was last changed. Click '>' to update it. Enter your existing password, then change it for something stronger — if you have a password manager, use that to generate and store a strong, random password.



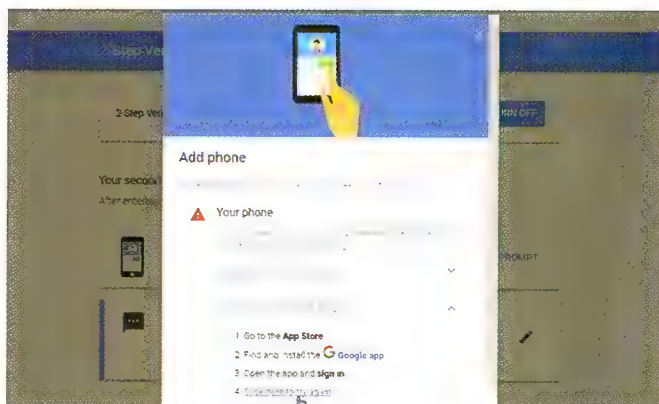
5 SWITCH ON TWO-STEP VERIFICATION

Two-step verification ensures you need a verification code along with your account password to sign into Google. It protects your account in case your password is compromised, and the code changes regularly for additional protection. The code can be delivered to your mobile phone. Click '>' next to '2-Step Verification', followed by 'Get Started' to start the process.



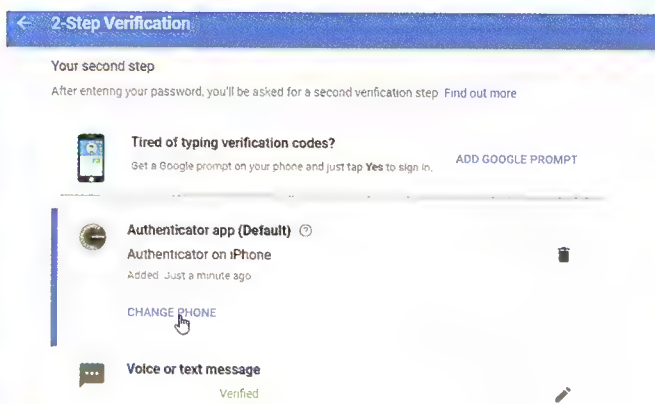
6 BASIC SETUP

Enter your password, then, if you've not already linked one, pick a phone number, as well as a delivery message: text is best for mobile; phone call for landline. Click 'Next'. A code will be texted or phoned through. Enter this and click 'Next' followed by 'Turn On'. You may have to get the message re-sent one or two times before it comes through — let's choose a more convenient method.



7 SELECT YOUR TWO-STEP METHOD

The most viable alternative is Google Prompt, which pops up on your phone when required — all you'll have to do is tap Yes to complete the sign-in process. Click 'Add Google Prompt' followed by 'Get Started'. This involves downloading, installing and signing into the Google app on your smartphone. Follow the prompts, sign into the app and then click 'Click here to try again'.



8 USE AN AUTHENTICATOR APP

If you have Google Authenticator or LastPass Authenticator on your phone, select the Authenticator option — which works when you're offline, too. Select your phone type, then open your app and use its camera to scan in the barcode or click 'Can't scan it' to manually enter a 40-digit alphanumeric code. Enter the code generated in the app to verify the connection.

Security Check-up



11 issues found

Third-party access

10 open issues

Your devices

Remove your account from your rk30sdk

Recent security activity

2 recent events

Sign-in & recovery

4 verification methods

[Continue to My Account](#)

Your devices

Remove your account from your rk30sdk



rk30sdk

Inactive for 218 days

You haven't used Google on your rk30sdk in 218 days. Sign out and remove your account from this device.

[REMOVE ACCOUNT](#)

Sign-in & security

Signing in to Google

Control your password and account access, along with backup options if you get locked out of your account.

Make sure that you choose a strong password

A strong password contains a mix of numbers, letters, and symbols. It is hard to guess, does not resemble a real word, and is only used for this account.

Password & sign-in method

Enter password protects your account. You can also add an alternate way to protect it with 2-Step Verification, which sends a 6-digit code to your phone for you to enter when you sign in. So even if someone manages to steal your password, it is not enough to get into your account.

Note: To change these settings, you will need to confirm your password.

Password

Last changed: 57 minutes ago

Microsoft Store Products Support

Account Your info Privacy Security Recovery Payment & billing Services & subscriptions Devices Family

Security basics

Make your account more secure

Changing your password



Make your password stronger or change it if you think someone else knows it.

[CHANGE PASSWORD >](#)

Update your security info



Make sure that your info is up to date. This is how you'll prove that you're you, if you ever forget your password.

[UPDATE INFO >](#)

Review recent activity



See when and where you've signed in, and let us know if something looks unusual.

[REVIEW ACTIVITY >](#)

Finished with the basics? Explore more security options to help keep your account secure.

9 USE APP PASSWORDS

Some apps don't support two-step verification — for these to work, you'll need to use a unique app password: click '>' next to 'App passwords' to set these up. Also review and, if necessary, update your account recovery options: email, phone and security question. Once done, select 'Your personal info' followed by 'About me' to review what information is publicly available.

10 STAY SECURE

Congratulations! Your Google account is now more secure, particularly with two-step verification enabled. We recommend performing this audit every six months — consider changing your password at least once every 12 months, too. Now roll this security audit out to other online accounts you have — including your Microsoft account, which has similar options. ■

Harden your WordPress security

Close the security loopholes in your WordPress-powered online site. Nick Peers explains how.

A self-hosted WordPress site – one not hosted on wordpress.com – is one of the easiest ways to build and maintain an independent web presence, whether it's a blog, online magazine, or even an ecommerce store. But one thing that's often overlooked with WordPress is security.

In this tutorial, we're going to perform a security audit, and enact several additional layers of protection to 'harden' your WordPress installation. Not only will you be surprised to learn how vulnerable your WordPress-powered site has been up until now, but you'll also be relieved to learn that, armed with the right settings and plugins, you can close most of its loopholes.

There are plenty of other ways in which you can toughen your WordPress installation, too. First, make sure everything – WordPress itself, and any plugins and themes you've installed – is fully up to date. Second, perform an audit of all the plugins you have

installed: Search for reviews to check they're legit, make sure you only install through the WordPress website, and remove those you don't need or use to free up resources. Once that's done, you're ready to make your WordPress site more resilient to hijackers and other malicious attacks.

1 HARDEN LOGIN

Log in to WordPress, navigate to 'Users > Your Profile', scroll down and click 'Generate Password' to create a strong random password. Copy this to your password manager (get one if you don't have one yet), and click 'Update Profile'.

Next, let's set up two-factor authentication, which means that even if someone breaks your password, they can't log in to your account without your mobile device and a suitable app, such as Last Pass Authenticator or Google Authenticator. Go to 'Plugins > Add New' and install Two-Factor Authentication from David Nutbourne. Click Activate, click the plugins icon to enable it,

then scan the QR code into your mobile app [Image A].

5 INSTALL ALL-IN-ONE PLUGIN

Go back to 'Plugins > Add New' to install All In One WP Security & Firewall, a 100% free plugin from Tips and Tricks HQ, which contains all the tools required to add multiple layers of security to your account. Once activated, look for the green shield icon in the left-hand pane, and click it. You're whisked to a dashboard with a handy Security Strength Meter. Chances are its score is incredibly low **[Image B]**.

Start by scrolling down to the Critical Feature Status. These four switches need to be on, so click the first one, which allows you to change your username from the unsafe default ("admin") to something more personal. Click the switch, then click 'Edit User' to change your username. Also, switch to the 'Display Name' tab to make sure that your display name isn't the same as your username.

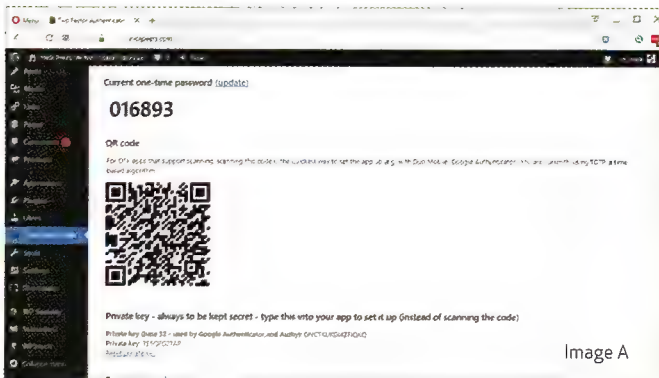


Image A

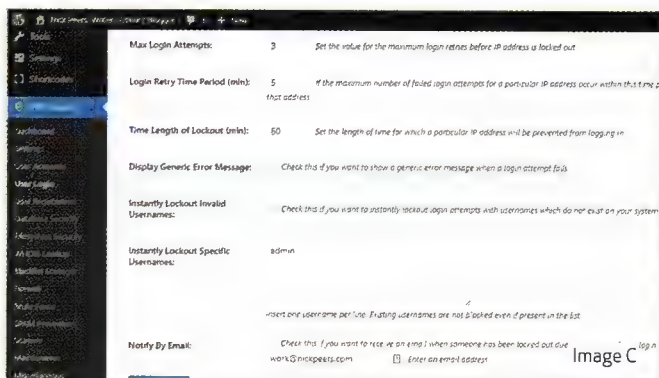


Image C

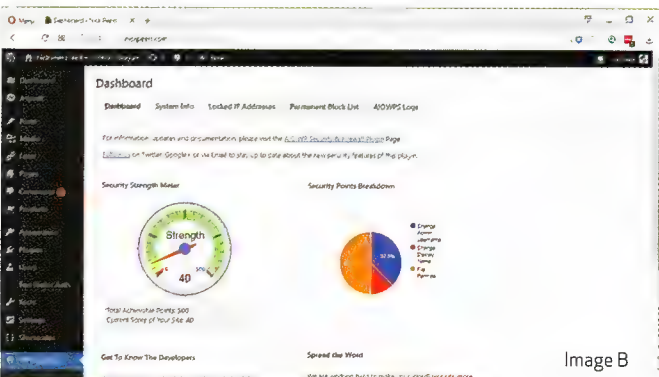


Image B

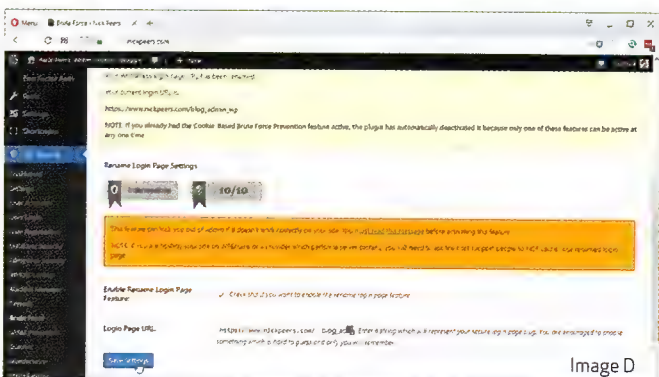
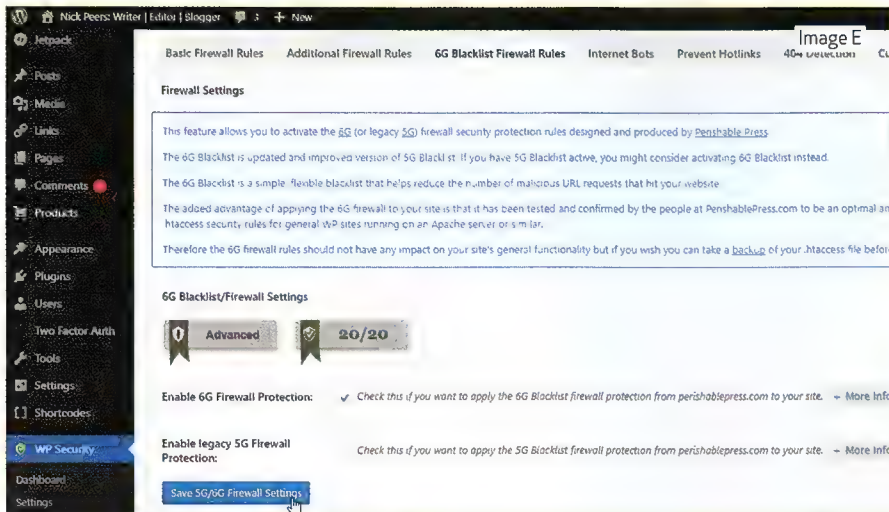


Image D



3 REDUCE BRUTE-FORCE ATTACKS

Return to the main dashboard and click 'Login Lockdown'. Start by checking the 'Enable Login Lockdown Feature'. This allows you to block specific IP addresses when they attempt – and fail – to log in. You have control over the number of failed attempts, and the time in which those attempts occur, plus how long the IP address is locked out. You can also instantly lock out attempts using invalid usernames, although a safer bet may be to add "admin" to the specific username list [Image C], now you're no longer using it. Click 'Save Settings'. You can be notified by email whenever an IP address is locked out, or just check the 'Failed Login Records' tab.

4 ELIMINATE BRUTE-FORCE ATTACKS

Go further by restricting the opportunities for brute-force attacks. Select 'Brute Force' under the WP Security icon, where you'll find several options for keeping hackers away from

your site. Some can be potentially dangerous – 'Rename Login Page' is one such option, but so long as you remember the name you give your wp-login.php page, you won't have any problems [Image D]. Other options include using cookies to block brute-force attempts, and a 'Login Whitelist' tab, where you can restrict access to specific IP addresses or ranges. If you're tempted by this option, be sure to check with your internet provider that your public IP address is static, or you'll end up locking yourself out when it next changes.

5 MORE ESSENTIAL TWEAKS

Click 'File Permission' to review the current permission settings of your WordPress installation files. Hopefully, they're correctly set to prevent outside interference, but if not, you can click 'Set Recommended Permissions' next to any that require it. Also consider disabling PHP File Editing, if you don't normally edit these files.

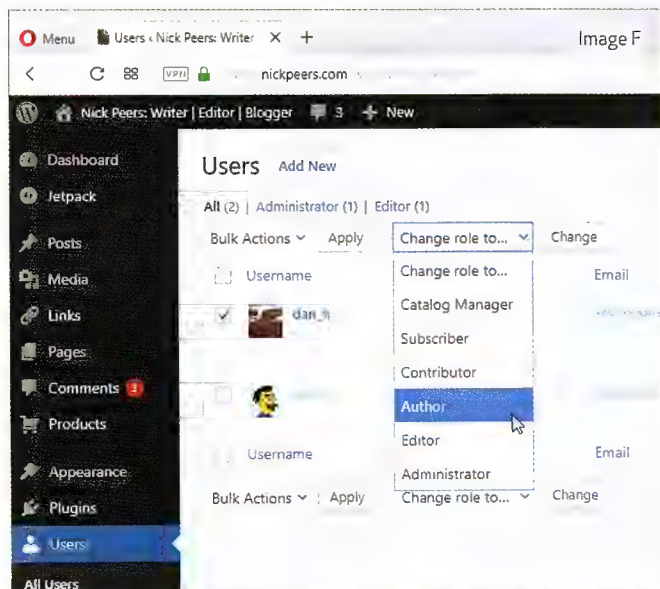
Next, select 'Scanner' to perform a check for file changes. This is a benchmark scan, so no problems will be detected – going forward, enable the automated file change detection scan to be alerted to any changes that could indicate the presence of malicious activity. The 'Malware Scan' tab merely redirects you to a paid-for solution that provides a more robust scan for a monthly subscription fee.

6 SWITCH ON FIREWALL

Finally, click 'Basic Firewall' to switch on the firewall, but click the link allowing you to back up your .htaccess file first – just to be on the safe side (this is backed up to your web space, so you need to download it using FTP or via your site host's control panel). Review the other options, too – for example, blocking remote access to the debug log file still allows you to access it when logged on through FTP. Also consider enabling the 6G Blacklist Firewall Rules [Image E]. Note, if any plugins stop working, either disable features or consider replacing them with similar plugins that play nicely with your hardened blog.

7 LIMIT USER ACCESS

If your blog is used by more than one person, make sure you're the only Administrator, and grant the minimum level of access required to other users for them to do their jobs. WordPress supports a wide range of user roles [Image F] – for those contributing to your blog, consider Author or Contributor to limit them to posting and managing their own posts. For trusted users, Editor allows them to manage other posts as well. Some plugins add additional levels – WooCommerce adds a Catalog Manager level, for example.



Force secure browsing

Protect yourself further by encrypting the connection to your blog using the secure HTTPS protocol, insulating you against malicious scripts, protecting data submitted to your site by visitors or customers, and improving search engine rankings. You need an SSL certificate to encrypt the connection, and this is done through the provider hosting your WordPress blog. You can purchase an SSL certificate, but check to see if your provider supports free certificates from Let's Encrypt. If it does, you can encrypt your website for free – note that Let's Encrypt certificates need renewing every three months.

Once set up – you may need to wait a few hours for DNS servers to update – install the Easy HTTPS Redirection plugin into your WordPress installation. Once installed and activated, switch it on under 'Settings > HTTPS Redirection'. If you later get warnings about insecure content, install and use the SSL Insecure Content Fixer plugin to resolve them.



Building a black-and-white workhorse PC

Get \$2,800 of balanced power with Alex Cox's yin and yang build.

THE CONCEPT

For most of the writers here at APC, the workhorse machines in our daily lives are typically paradoxes. The digital equivalent of the ship of Theseus; every part of them transplanted and replaced over the past decade, until nothing of the original truly remains. So are they still the same PCs? More to the point, for this humble writer, has it really been a decade since he last sat down with a desk full of components and built a rig from scratch? The former question will remain paradoxical, but the latter has a new answer: no. He's built a new

machine to escape the ridicule and derision of the APC team, and bring our lumbering skills back up to scratch.

As is, no doubt, hugely apparent, a massive part of our decision-making process when spec'ing up this machine was our desire for an alternate aesthetic. The black-based glowing RGB monolith is a modern staple, but we've added contrast and brightness, pulling out lurid colour in favour of a slick monochrome combo. Liquid cooling is all the rage, but without the budget for such frippery (and with a mind to do something different yet traditional), we've opted for massive

negative pressure airflow. All components included, there's a total of 10 fans spinning away inside.

Our sub-\$3,000 budget (and that overarching colour scheme) really determined the makeup of the PC itself, but even after splurging on fancy fans, we've not been forced to skim on the goods. It's landed squarely at the mid-range, with Intel's 4GHz, quad-core Core i3-8350K (probably the best overclockable chip you can get with limited cash right now) sitting at its heart.

MONOCHROME MEDITATION

Approaching a fresh, modern case as someone who's scraped their knuckles on cheap Chinese boxes in the past is a revelation. While so many aspects of the PC building process have remained familiar over the past 10 years, there's an astonishing level of logic, flexibility and build quality evident in NZXT's white-outered H400i microATX mini tower case. It's made for cable routing, for pretty builds, for compact constructions, for a subtle first glance, and a remarkable second, and it's just brilliant to work with.

Getting massive airflow into the case meant ripping out the stock fans and raiding Noctua's warehouse for a stack of cooling gear, namely a foursome of NF-A14 140mm fans for the rear and front of the case, an NF-F12 fan for rear exhaust, and a pair of the same to replace the decidedly not-monochrome brown fan of the NH-U12S cooler. Each fan includes replaceable corner vibration dampeners in a host of colours – critically, for us, four each of black and white. Topping it all off is a white NA-HC2 cooler cover to make the CPU pop and complement the H400i's cable tidy bar.

It might seem like we've chosen the components specifically for their hue: the gloomy ASUS RoG Strix Z370-G mobo, the bright glossy ASUS GeForce GTX 1060, the white LED brilliance of Corsair's Vengeance RAM, the mat ink of a 500GB Samsung 850 Evo SSD up front on display, the milky braided modular tentacles of the Corsair RM750x PSU. And we have. But, damn, that Core i3-8350K needed a collection of capable counterparts to really make it fly, and that's precisely what we've offered it. For a mid-range build, we'd expect this to burn through the benchmarks right now, and give us plenty of room for future expansion.

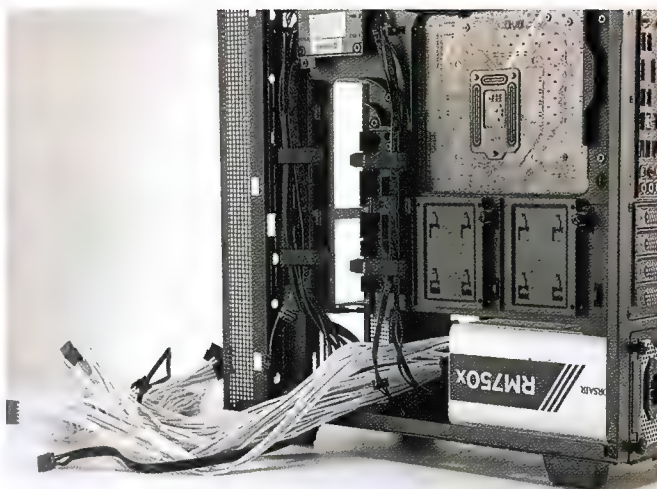
PARTS LIST

PART		STREET PRICE
CPU	INTEL CORE I3-8350K	\$260
GPU	ASUS GEFORCE GTX 1060 6GB DUAL	\$429
MOTHERBOARD	ASUS ROG STRIX Z370-G GAMING MICROATX	\$289
RAM	16GB (2 x 8GB) CORSAIR VENGEANCE WHITE LED DDR4	\$419
M.2 SSD	KINGSTON KC1000 M.2 PCIE SSD 480GB	\$349
2.5-INCH SSD	SAMSUNG 850 EVO 500GB	\$209
PSU	CORSAIR RM750X WHITE PSU + CABLE KIT	\$219
CASE	NZXT H400I MICROATX WHITE MINI TOWER CASE	\$209
CPU COOLER	NOCTUA NH-U12S	\$99
ACCESSORIES	NOCTUA NA-HC2 CHROMAX WHITE CPU COOLER COVER	\$39
FAN 1	3 x NOCTUA NF-F12 PWM CHROMAX BLACK SWAP 120mm FANS	\$117
FAN 2	4 x NOCTUA NF-A14 PWM CHROMAX BLACK SWAP 140mm FANS	\$135
TOTAL		\$2,773



1 GET NAKED

Starting from scratch is both the best way to get your head in a build and the key to a clean, organised machine. Gaining full access to that case means tearing it to shreds at the beginning. Everything that can be removed needs to be removed, including the front panel and dust filter, the tempered glass side and white rear cover, the nifty cable tidy bar (which takes a bit of bending to free it), and the stock fans. With as much elbow room as possible freed up inside, it's time to start working from the bottom up, pressing the padded rear port panel into place, then bolting down the mobo after screwing in an extra pair of standoffs to support it.



2 CABLE CONUNDRUM

Although there's lots of room to stuff cables into the rear of the H400i's PSU bay, we've gone for a modular PSU, because even the copious routing channels on the rear panel will get overloaded by a full contingent of individually braided strands. Before installing the PSU, we added only those cables that were absolutely necessary, plugging them into the left-most sockets to minimise the wrist-twisting acrobatics required to add outlets if upgrading in the future, then removed the PSU bracket from the rear of the case, screwed it on to the PSU, and posted everything in, sending the cables out the back of the case to be properly routed later on.



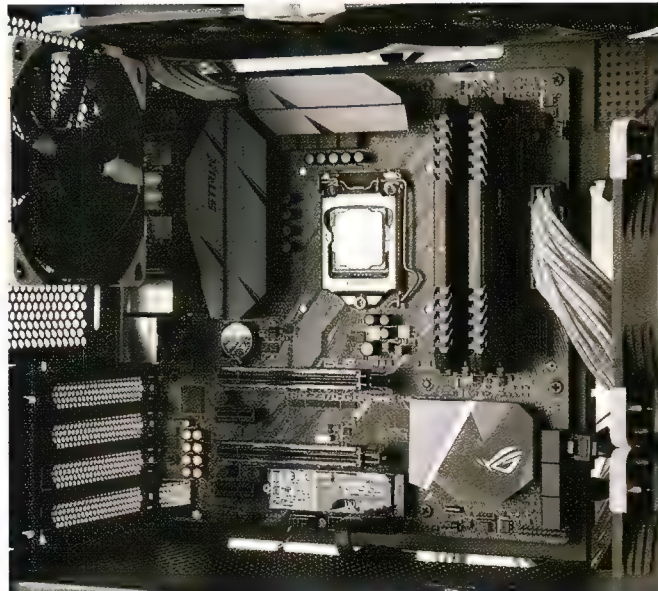
3 FAN FINAGLING

Before the case gets too crowded, and with the motherboard and PSU safely in place, it's time to install the case fans. This is a dull and arduous process that means adding eight awkward silicon vibration dampeners to each edge of each corner of each fan, being mindful of the airflow direction of each fan — we're dragging air in through the front, and exhausting it through the top and rear of the case. We chose to add the white bumpers to the fan side facing the inner of the case, so we only needed to consider the rotational orientation of the fans (and the egress of their cables through the back of the case) at install time; had we instead put them on the window side, we'd have had to consider the cables much earlier.



5 COOL IT

Oddly, installing the CPU cooler is one of the trickiest bits of this build. It requires a bit of pre-preparation, pulling the brown Noctua fan off (and keeping it carefully aside, because it's awesome, and the only reason we're not using it here is its colour), and removing its wire clips, then preparing the pair of 120mm fans, equipping them with clips, and considering both the direction of airflow and the location on the motherboard of the CPU fan headers. Bracket on, cooling paste on, cooler on. We then clip on the fan that's furthest from the fan headers, plugging it into the OPT header, which will become inaccessible once we've clipped on and plugged in the one on the other side. The magnetic mount for the cooler cover needs to be added next, followed by the second fan, then the white cooler cover simply drops on over the top.



4 HOOK IT UP

Here's a bit of inside information: We made it through this build with only one tiny finger wound, and it's not entirely clear where that came from. We blame our atypical lack of injury mainly on the formulaic, logical, top-down outside-in build process we employed. Thus the next step: installing those painful motherboard cables and headers that require improbable finger gymnastics if there's anything else in the case, and routing them neatly out of the way at this early stage. Then it's in with the RAM — in the motherboard's second channel, to ensure good clearance from the fan-laden cooler — in with the CPU, and in with the Kingston M.2 SSD, after liberating it from the PCIe card it initially comes attached to.



6 FINAL STEPS

Time to finish up, and it's a relatively simple process. The Samsung SSD goes in the cradle on front of the PSU bay — route the SATA cable and power through the handy hole next to it, and catch the flying springs that are released when you pop the cradle off — and then we install the graphics card; we initially routed the six-pin power cable through the back of the machine, and later moved it to the much more attractive hole on top of the PSU bay. With all the components ensconced, the cable tidy bar reinstalled, and the cables beautifully routed on the back, and definitely not all stuffed haphazardly into the main recess, the front and sides of the case can go back on at last.



- 1 Without the bright white cooler cover, this machine wouldn't have nearly the same impact. It's a real highlight, well worth the small investment.
- 2 The cable tidy bar is a lovely touch, and another visual win. It's notched, so you won't have trouble fitting a full-length graphics card in the case.
- 3 Mounting our SSD here is a little ostentatious, but there is a pair of additional 2.5-inch mounting bays hidden in the back of the machine if we were thinking of being more discreet.
- 4 We love the spaghetti of the PSU's modular cabling, particularly when emerging from the dedicated notch in the base of the case.

Penguin power

Changing pronoun from the APC "we" to the personal "I" for a moment, this machine marks a proud moment. It's the neatest PC I have ever built and, after only a tiny bit of troubleshooting — one forgotten front panel connector — it ran perfectly. Well... mostly. We'll come to that. NZXT's H400i is so well designed it almost generates its own logic; once it's stripped and clear, an easy process with only a little screwdriver-slinging, it all but invites you to build your PC right.

Not that we did exactly. There were missteps — 10 minutes fighting to screw in the M.2 SSD after forgetting to add its tiny standoff to the mobo, and placing the milky white case side

on a not-so-clean surface — and there are a few things we'd do differently if we were to do it all again. The fans, for example, each connect to their own extension cables, but the H400i's integrated fan controller cables would have reached them directly.

Cable combs might have made the motherboard's 24-pin power connector less tentacly and more uniform. Doubling the build time to route the cables neatly around the back would have been mentally pleasing, but quite unnecessary.

We've yet to work out why we've been unable to initialise the M.2 drive on board, but it's seen in the BIOS and in Windows, so it's probably ridiculously simple. Aside from that, performance

is spectacular for a machine of this price, and it's cool and quiet, even when taking a hammering. Partly, that's down to the CPU. When it first dropped, we half ignored its potential, but the quad-core Core i3-8350K pulls off solid rendering performance, solid gaming, solid everything, all at a price that redefines the low end. It's unlocked, so we could clock it up even higher if push came to shove — the massive amount of cooling we've built into the case will take care of it, and the extensive reservoir of excess power in the RM750x PSU means we're more than ready for chips with a higher TDP, or a fatter GPU.

Benchmark results, if anything, were a touch higher than we were expecting on the CPU side, and about where we'd thought they would land on the GPU side. While, of course, they lag behind the numbers of the R9 Fury X in our APC Labs test build — no surprises there — that GeForce GTX 1060 out of context is no slouch, and it's a good entry-level choice that will keep you going (at its level) until you're ready to invest in one of its heavier siblings. Perhaps, were we to do this build again, we would invest a little less in a storage solution that we couldn't get to work, and more in a 1070, or even a 1070 Ti — just as long as we could find a white one, that is. ■

BENCHMARK RESULTS		
	APC LABS TEST PC	THIS SYSTEM
CINEBENCH R15 MULTI-THREAD	987	672 (-32%)
CINEBENCH R15 SINGLE-THREAD	196	174 (-11%)
TECHARP'S X264 HD 5.0.1 (FPS)	21.93	15.94 (-27%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	1,895	549 (-71%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	949	519 (-45%)
RISE OF THE TOMB RAIDER (FPS)	41	41 (0%)
THE DIVISION (FPS)	78	60 (-23%)
3DMARK: FIRE STRIKE (INDEX)	15,026	10,502 (-30%)

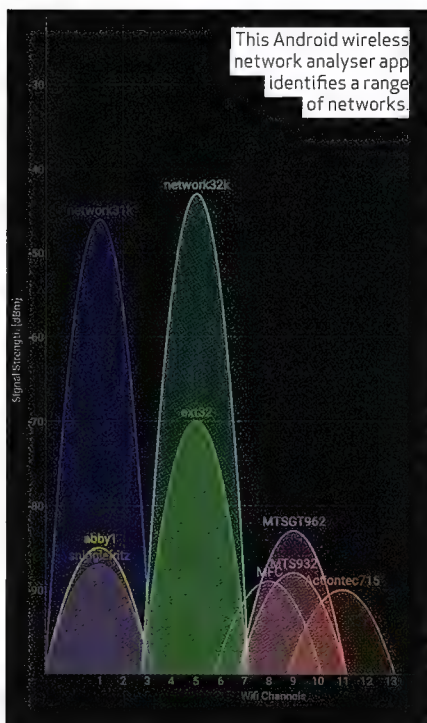
Our APC Labs test PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM. All games are tested at 1080p on max settings, with HD texture packages installed.

Troubleshoot your Wi-Fi with a Pi

Hold on to your hats, as we join Sean Conway riding the RF waves to gain the knowledge needed to understand the inner workings of wireless.

All you wanted to do was stream that video, copy that file or try to view a few photos, but the Wi-Fi chooses that exact moment to play up. It's a problem we've all encountered. How do you troubleshoot a wireless connection? With some basic radio frequency (RF) transmission theory knowledge, an understanding of the local environmental conditions and a few simple Raspberry Pi Linux applications, you'll be better prepared to tackle Wi-Fi connection issues in the future and bedazzle fellow pub goers with your IEEE 802.11 knowledge, too!

This tutorial make the assumption that you have some basic experience with a Raspberry Pi. What does that mean? It's always a struggle to determine what to put into a tutorial verses what to leave out. Here, the assumption permits the author to minimise details on some common Pi tasks, in favour of greater details on tasks the tutorial is designed to cover.



An example would be using a compatible Pi Wi-Fi attachment. If you're not confident in your own Pi Wi-Fi attachment, we've assumed you've already looked into the matter, such as search around on Google search.

In this scenario, the Raspberry Pi will be the host trying to connect to a vendor's modem (the access point, or AP) that supports wireless. Here's a bill of materials for the setup used in this tutorial:

- OS: 2017-01-11-raspbian-jessie.img
- Hardware: Raspberry Pi Model B (Rev 2.0, 512MB): revision 000E
- Wi-Fi: Ralink Technology, Corp. RT5370 Wireless Adapter

To install the raspberry Pi OS consult the www.raspberrypi.org site. The URL is the first choice when looking for all things Pi. The link reflects instructions that are relevant to the current OS (also see www.raspberrypi.org/documentation/installation/installing-images).

With the OS installed there are a few raspi-config options that are employed to tailor the OS. You can expand the file system to take advantage of the larger memory cards being used, and personalise the device by giving it a hostname. Internationalisation options are tweaked to accommodate what side of the Atlantic the Pi resides. Turning on SSH and turning off a GUI console imposes the command line interface (CLI). A final touch is a password change. To keep the bad guys out, never leave password defaults unattended. The reference link www.raspberrypi.org/documentation/configuration/raspi-config.md can provide the specifics we've just summarised here.

A quick reboot of the device to confirm all the options are in order. Then perform a command line update and upgrade as the final step before we establish the Pi setup for staging this WiFi tutorial.

Wi-Fi Pi

To start the exercise, the Pi is connected to a wired network. This enables an SSH connection to

the terminal command line interface. Install the Wi-Fi dongle. USB attachments can be installed or removed with the Pi power on. Examine the dmesg logs to gather information on the dongle. If you're using a wireless attachment that's not compatible with the Pi, it may not be detected.

```
dmesg| grep -i usb
[ 2.317400] usb 1-1.2:
Product: 802.11 n WLAN
[ 2.317409] usb 1-1.2:
Manufacturer: Ralink
[ 2.317418] usb 1-1.2:
SerialNumber: 1.0
[ 10.538936] usb 1-1.2:
reset high-speed USB device
number 4 using dwc_otg
[ 10.890759] usbcore:
registered new interface
driver rt2800usb
[ 21.067053] rt2800usb
1-1.2:1.0 wlan0: disabling HT
as WMM/QoS is not supported by
the AP
[ 21.067074] rt2800usb
1-1.2:1.0 wlan0: disabling VHT
as WMM/QoS is not supported by
the AP
```

The operating system appears to have found the Wi-Fi dongle. Another quick command line listing of USB devices obtains the details of the dongle:

```
# lsusb
Bus 001 Device 004: ID
148f:5370 Ralink Technology,
Corp. RT5370 Wireless Adapter
.....
```

It stands to reason that, if the Pi has detected the Wi-Fi dongle, it should load the driver modules so the OS can communicate with the device. An rt2800usb was detected by examining the output of the dmesg command. The parsed output of the list modules command displays the rt2800, drivers and software libraries.

```
# lsmod
Module                               Size
Used by
.....
rt2800usb                           18973
0
rt2800lib                           82219
1 rt2800usb
rt2x00usb                           12964
1 rt2800usb
rt2x00lib                           49062
3
rt2800lib,rt2800usb,rt2x00usb
.....
```

Using the instructions provided at www.raspberrypi.org/documentation/configuration/wireless/wireless-cli.md to configure the Pi for wireless. It's recommend that administrators employee the wpa_passphrase command to build the configuration. Using this option prevents passwords from being transmitted in plain text.

Let's leave the Pi world for a minute, to examine a free app, called Wifi Analyzer for Android that displays wireless networks. The app presents parabolic waveforms in different colours. Each colour represents the signal strength of the different network AP that's been detected.

After that short Android interlude, let's get back to the Pi. If you didn't do a reboot after configuring the Wi-Fi, do it now. A dmesg check will confirm if the device is configured correctly with a wlan0 interface, and is ready for use:

```
# dmesg
[ 21.227676] wlan0:
authenticate with
00:15:05:f8:f7:c8
.....
[ 21.345086] wlan0:
associated
```

'wpa_cli' is a command line front-end program for interacting with 'wpa_supplicant'. The command enables the user to check the current status, change the configuration, trigger events and request interactive user input. The output of the wpa_cli command provides numerous details related to a wireless device and the signal. Before employing the commands, it would be handy if you had some additional knowledge of radio frequency (RF). This is a good point to take a detour from all stuff Pi-related and explore some RF theory.

REAL LIFE RADIO FREQUENCY

A recent project required a wireless connection from a Raspberry Pi to a home router AP. The network could use one of two different residential gateways (RG) as APs. RGs are sometimes referred to as routers or modem. To be clear, it's the device that's responsible for connecting to the Internet Service Provider (ISP), which is providing access to the internet.

One RG was built with an external movable rubber duck antenna and the second RG had the antenna built into the device. Built-in antennae may be wrapped around the inside of the device, such as early generation Apple iPhones, or the antenna can be built into the motherboard, just like current version of the Raspberry Pi-Zero.

RF signals are transmitted and received with an antenna. In the diagram (right), there's a rendering of a vertical dipole antenna, with a signal source attached, radiating an RF signal energy out from the antenna in a torus pattern. Radiation pattern A in the drawing shows the torus or doughnut radiation pattern. The signal energy is equal in all directions. Devices that transmit and receive radio waves require antennas with a RF signal modulated (in other words, containing) with data.

Linux wireless configuration file

To configure wireless on a Raspberry Pi, the user has to edit the configuration file at /etc/wpa_supplicant/wpa_supplicant.conf. 'wpa_supplicant' is the IEEE 802.1X/WPA component that's used in the client stations. The protocol implementation provides key negotiations with a WPA authenticator, controls the roaming, and the IEEE 802.11 authentication/association for the wireless driver. The user invokes the supplicant and submits credentials to establish the computer connection on a secure network. If the authentication succeeds, the authenticator permits the computer to connect to the network.

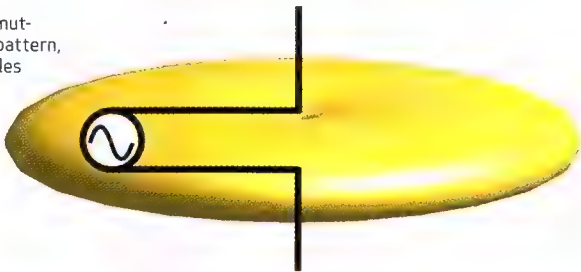
Antennae are designed to radiate RF energy. How the antenna is physically constructed will affect the radiation pattern. Some antennae are engineered to transmit a very directional signal pattern. The radiation pattern identified with the letter B in the diagram focuses the RF energy out in one direction with very little radiation from the back. This enables greater range in a specific direction, although there's a loss of signal in the opposite direction.

When using a hand-held transmitter like a walkie-talkie, best practice is to hold the device with the antenna

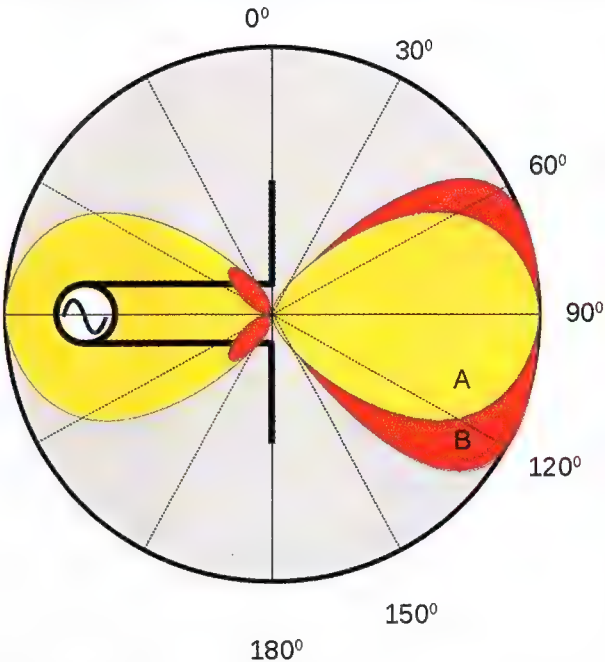
vertical. In Hollywood action films, the protagonist holds the walkie-talkie radio transmitter horizontal for a better profile shot. With a horizontal antenna orientation, the signal will be at its weakest when the tip of the antenna is pointing in the direction the rescue aircraft is coming from. If the character is surrounded by tall, metal buildings, the signal strength radiated is reduced to the point he may not be able to transmit a strong enough signal for his rescue ride to receive.

Now that we have an understanding of antenna design, their resonant frequency, antenna orientation and

Here's a doughnut-shaped signal pattern, without sprinkles or chocolate.



signal source attached to antenna showing RF radiation pattern



RF radiation pattern of vertically mounted antenna

an awareness that obstructions can block signals and reduce signal strength, how is it applied?

There are two aspects that we need to understand using a wireless network: the ability to connect to the AP, and the data throughput delivered. The stronger the RF signal, the easier it is for the remote device and the AP to make a connection. More signal also means improved data throughput.

But wait — we also need to talk about noise. If you've ever listened to AM radio (*How old are we?! — Ed*) during a thunder storm, you may have heard crackles and pops during the broadcast. That's noise generated by the storm. Noise are errant signals generated by another sources that fall into the frequency range being used by a device. It affects the device's ability to receive or read a signal.

What's most important is the ratio of signal strength to noise strength. The noise strength needs to be lower than the signal strength for optimal reception. If the signal-to-noise ratio is low, then it becomes difficult for the receiver to pull the signal out of the noise.

RF signal strength is calculated using a formula that provides a value in dB (decibels). 0dB is the middle of the scale. The more positive the number, the greater the signal strength. The more negative the number, the weaker

the signal strength. The maths required to develop an understanding of the concept depends on slide rules or logarithmic tables. Additional theory on top of the content already covered would be a tad excessive for a Raspberry Pi tutorial. Much like cursive writing exercises at school, the benefit of gaining the knowledge versus just using a tool to arrive at the solution is always cause for debate.

On many wireless devices, a basic signal strength meter is provided using signal strength bars. The more bars, the greater the signal. The bar equivalent signal strength isn't normally provided. It's assumed that the greater number of bars on show, the better the reception. The diagram (below) provides a translation between bars of signal strength and dB.

-30dB is the maximum signal strength that a device can obtain. Close proximity to the access point with no obstruction will achieve this. Between -67dB and -70dB is needed for reliable packet delivery. -80dB is the minimum to make a connection. -90dB is so far down in the mud that it becomes difficult for a device to separate signal from noise.

The author's spouse had some concerns when she came home from a weekend away and discovered the backyard Wi-Fi signal lab encroaching on the senior residence at the rear of

our property. The red cones (see the photo far right) were markers in increments of 3 metres to measure distance.

An extension cord was needed to feed power to the Wi-Fi supported Raspberry Pi that was sealed in a weatherproof box. Two modems (RGs) with different antenna types were used for evaluation. It rained part way through the testing so the sealed black box that housed the Pi came in particularly handy.

BACK TO THE PI

This detour was taken to gain some RF knowledge before using the command line tool `wpa_cli`. Armed with this knowledge, let's now examine some criteria that can be considered when looking at improving the response of the Wi-Fi network.

What wireless interfaces are available?

```
# wpa_cli interface_list
Selected interface 'wlan0'
What's the status of a given wireless interface? Results of all interfaces will be displayed. The Pi for the tutorial only had one interface (wlan0):
```

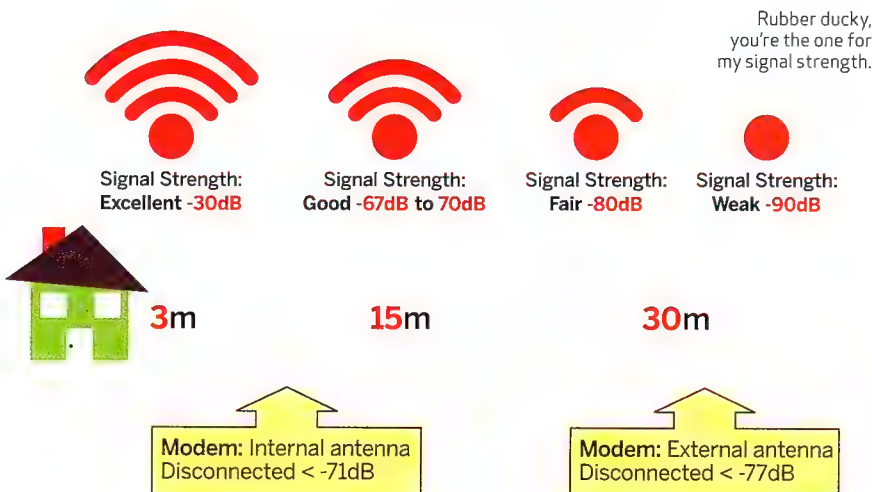
```
# wpa_cli status
Selected interface 'wlan0'
bssid=00:15:05:f8:f7:c8
freq=2432
ssid=network32k
id=0
mode=station
pairwise_cipher=CCMP
group_cipher=TKIP
key_mgmt=WPA2-PSK
wpa_state=COMPLETED
ip_address=192.168.2.203
address=00:c1:41:39:00:83
uuid=944aa377-ebda-5ab2-a510-b8c81a5c4f1b
```

How about supporting a ping command?

```
# wpa_cli ping
Selected interface 'wlan0'
PONG
```

What networks can the device connect with?

```
# wpa_cli list_networks
Selected interface 'wlan0'
network id / ssid / bssid /
flags
0 network32k any
[CURRENT]
```



Radiant knowledge of the spotless antenna

Engineering an antenna to create a specific signal radiation pattern is also dependent on the frequency of the signal to be transmitted. Antennae provide optimal power transmission when they're tuned to the resonant frequency of the source signal. That means an antenna operates most effectively at a specific frequency. Some RGs provide an administration console to adjust the power and channel (in other words, the frequency)

that the device is operating at. If there are a number of RG transmitting in an apartment block on the same frequency, then it can create problems for the receiving device to lock on to a specific AP signal, especially if the AP signal is weak compared to the others. Analyse the signals in your area and pick a channel that's least congested to help improve wireless performance.


```

1 any
[DISABLED]
What other networks are in range
and available? One command initiates
the scan while the second command
displays the results.
wpa_cli scan
Selected interface 'wlan0'
OK
And the second command...
$ wpa_cli scan_results
Selected interface 'wlan0'
bssid / frequency / signal
level / flags / ssid
00:15:05:f8:f7:c8 2432 -67
[WPA-PSK-TKIP][WPA2-PSK-CCMP]
[ESS]network32k
10:9f:a9:b2:a2:d92462 -59
[WPA-PSK-CCMP+TKIP][WPA2-PSK-
CCMP+TKIP][ESS]
snigglefritz
00:1c:b3:af:cc:9a 2437
-63 [WPA-PSK-TKIP][WPA2-
PSK-CCMP+TKIP][ESS]network31k
10:9f:a9:b1:77:f9 2452 -77
[WPA-PSK-CCMP+TKIP][WPA2-PSK-
CCMP+TKIP][ESS] MTS6T962

```

It looks like four networks have been discovered. The two scans prefixed with network are the APs used in this tutorial. If you're familiar with ipconfig for wired networks, then iwconfig provides similar results for wireless networks. Like ifconfig, in the wireless environment, iwconfig can be also used to manipulate basic wireless parameters:

```

$ iwconfig
wlan0 IEEE 802.11
ESSID:"network32k"
Mode:Managed
Frequency:2.432 GHz Access
Point: 00:15:05:F8:F7:C8
Bit Rate=24 Mb/s
Tx-Power=20 dBm
Retry short limit:7
RTS thr:off Fragment thr:off
Power
Management:off
Link Quality=39/70
Signal level=-71 dBm
Rx invalid nwid:0
Rx invalid crypt:0 Rx invalid
frag:0
Tx excessive
retries:6213 Invalid misc:38
Missed beacon:0

```

The command output shows what network the Pi is connected to and the signal strength. The next two commands provide similar details already displayed using the other commands. 'iwgetid' provides the network connection, with 'iwlist' provides scanning, list frequencies, bit-rates, encryption keys and so on. Wi-Fi quality and power readings are also available, by examining the contents of the wireless file in the /proc directory.

```

$ cat /proc/net/wireless
Inter-| sta-| Quality

```



```

| Discarded packets
| Missed | WE
face | tus | link level
noise | nwid crypt frag
retry misc | beacon | 22
wlan0: 0000 43. -67.
-256 0 0 0
6213 38 0

```

Considering we just installed an OS, did a few tweaks, added new Wi-Fi hardware and a configuration change, then detoured to take in some RF theory, you may be feeling a bit overwhelmed. All the commands provided are supported by man pages. Prefix the command in question with man separated by a space and you'll soon gain some further insight into the command operation.

How about looking at one more command that consolidates the output from a number of commands which have been used so far.

```

$ sudo wavemon

```

The output from the command is an active screen in real time displaying a number of the Pi's Wi-Fi parameters. Remember that noise can have an effect on receiving a signal. The 'wavemon' output presents the link quality and signal level to demonstrate the concept.

TAKE IT OUTSIDE

Now that we have an understanding of some wireless commands, how about a practical application? Use the commands to answer this question: what differences does it make using an AP with an external antenna vs an AP with an internal antenna? To answer, connect the Pi to the wireless network that has an external

antenna AP. Record signal levels and the greatest distance a connection can be maintained. Now complete the same exercise using an AP with an external antenna. In this scenario, the wavemon and /proc directory were used to show the readings as the Pi was moved. Revisit the diagram showing signal strength (far left). The data for the two APs with different antennae is included. The connection range was greater for the device with the external antenna.

The collection of photos (above) shows the professional engineering lab (Ahem... — Ed) used to conduct the testing scenarios. The two different modems (the APs) were inside the author's home above the electrical panel. On the outside, they're located just below the attached gazebo. The red cones shown in one of the pictures were distance markers in increments of 3 metres from the AP. A few extension cords were needed to feed AC power to a Wi-Fi supported, Raspberry Pi sealed in a weather-proof box. If you look closely at one picture you should notice that it's raining. (All in a day's work to bring you your issue of APC each month! — Ed)

There you have it: the command line workings of Wi-Fi on a Raspberry Pi. We hope the detour into RF theory didn't overwhelm you. To fully appreciate the Wi-Fi commands, it's important to have some RF background before exploring their use. The Wi-Fi commands are an excellent box of tools to open up in helping to try to resolve problems. ■

Play C&C: Red Alert on a Raspberry Pi 3

Go back in time with Nate Drake to experience a classic on your Pi.

Hitler's Time Travel Exemption Act, as decreed by the website TV Tropes (www.tvtropes.org), states that all fictional attempts by time travelers to murder the Great Dictator will either fail or otherwise be disastrous. This is, in fact, the exact premise upon which Westwood Studio's 1996 classic game *Command and Conquer: Red Alert [Image A]* is based. In the alternate

history of *Red Alert*, Einstein decided to turn his genius to creating a time machine, rather than an atom bomb. He travels back to 1924, and kills Hitler with no more than a handshake. With no opposing Germans, the Soviet Union under Josef Stalin begins to roll across Europe, while the Allies desperately try to halt their advance. The game is non-judgemental, and lets you play as either faction.

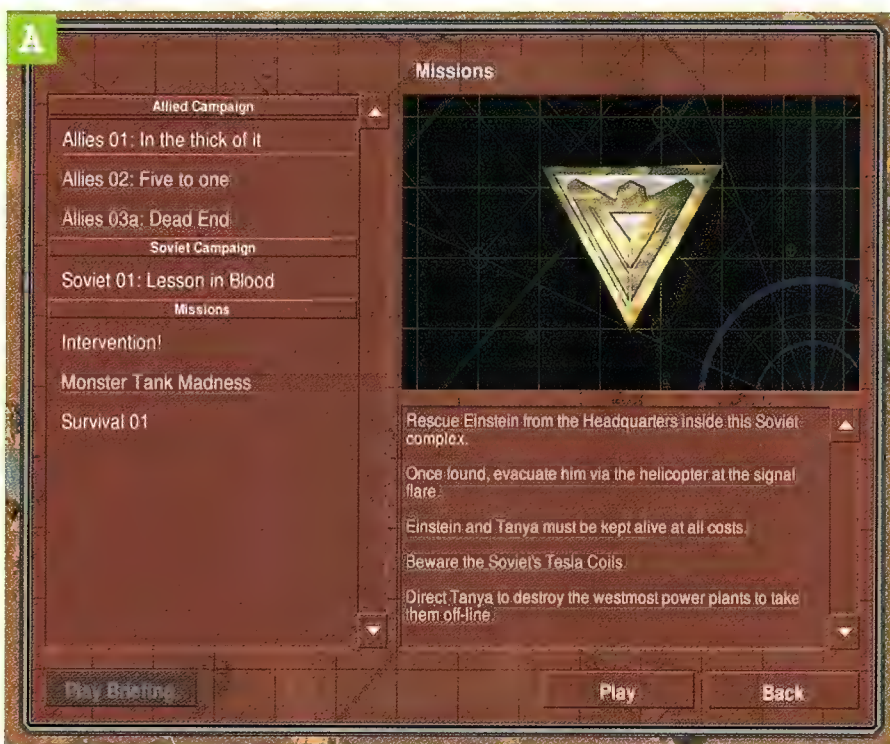
20 years on, this excellent RTS (real-time strategy) game is now eminently playable due to the fan-made free and open-source OpenRA engine, enabling you to play *Red Alert* and other Westwood classics directly on your Raspberry Pi. Although you can technically play these games using emulators such as DosBox and Exagear, we feel that taking the OpenRA option makes for a much smoother gaming experience.

In order to proceed, all you need is a Raspberry Pi 3 with a clean install of the latest version of Raspbian Stretch. Make sure you run `sudo apt-get update` then `sudo apt-get upgrade` before downloading the OpenRA files.

1 THE SPICE MUST FLOW

The C&C franchise kicked off with the original *Command & Conquer* (sometimes called *Tiberian Dawn*), which was released in 1995. This, in turn, was based on Westwood's desire for a more realistic RTS game after the release of the archetypal *Dune II: Battle for Arrakis* in 1992. OpenRA supports playing these C&C titles, as well as *Dune 2000*, a partial remake of *Dune II*.

Both the original C&C and *Red Alert* games have also been released as freeware by Electronic Arts. Follow the steps in the boxout opposite to get OpenRA running. On first launch, the engine asks you to 'Choose your Battlefield' [Image B]. From there, you can select your chosen game. OpenRA can download the game files for each title for you. However, if you do have the original CDs, consider using these instead, because the downloaded files



Boost your war machine

Despite the age of the games, gameplay within OpenRA is very sluggish on the Raspberry Pi by default — with the exception of *Dune 2000*. You can tinker with this from within the games themselves by entering the Settings menu, and altering the framerate. You can also change the Mode from the default (Pseudo-fullscreen) to Windowed and even specify the window size. Click Reset to return the settings to their defaults, or click Back to confirm your changes. The game then restarts. Getting the resolution right can be

tricky. If you make a mistake, open Terminal, and run `nano ~/.openra/settings.yaml`. From here, you can change the 'Graphics Mode' and 'Window size'.

If you want to give your Raspberry Pi a real shot in the arm, you could try enabling the experimental OpenGL driver. Close any open applications, then open Terminal. Run `sudo raspi-config`, and use the arrow keys to choose 'Advanced Options'. Next, choose 'A6 GL Driver'. Enable the first option starting 'G1 (Full KMS)'.

The Pi's Advanced Options section also contains a 'Memory Split' option, whereby you can choose to increase the dedicated amount of memory for the GPU, which may also improve performance. Choose 'A3 Memory Split' under Advanced Options to change this from the default (64MB) to a higher value — 256MB, for example.

Use the arrow keys to select Finish, then choose Yes to reboot the Pi. Hopefully, you'll find the tide of battle flowing a little faster now...



don't contain any sound or video sequences.

- If you decide to use a CD, you need an external DVD drive connected to a powered USB hub to read it from the Raspberry Pi. Alternatively, copy the ISO file to a USB stick, and connect it to the Pi. Open Terminal, and create a mount point, such as `sudo mkdir -p /mnt/disk`. Next, use `cd` to switch to the directory with the ISO file, and mount the ISO file itself using the mount command:

```
cd /home/pi/Desktop
sudo mount CDE_SOVIET_DISC.ISO /mnt/disk/ -t iso9660 -o loop
```

- OpenRA detects that the files are mounted, and copies the game data next time you launch.

2 MULTIPLAYER MODE

OpenRA is available for all major platforms, so you should be able to play against your friends, too, no matter what OS they're running. After you've compiled the code, open Terminal, and use `cd OpenRA` to switch to the game folder, then `sudo cp /usr/lib/`

`openra/launch-dedicated.sh /usr/lib/openra/my-dedicated.sh`. You can then edit your game server settings by running `sudo nano usr/lib/openra/my-dedicated.sh`. Amend `Game.Mod=ra` to `Game.Mod=cnc` or `Game.Mod=d2k` to play the original C&C and *Dune 2000* [Image C], respectively. Set a password for your server by amending `Server.Password=PASSWORD`. For more information, see github.com/OpenRA/OpenRA/wiki/Dedicated.

- If your friends are connecting via the internet, you need to set up port forwarding on your router. Specific steps for this vary from router to router. However, you can find some tips for getting started at portforward.com, which covers all major models. By default, the server uses TCP Port 1234.

3 FOG OF WAR

The official position of the OpenRA project is that the engine can run on Raspbian, but games cannot be played on the Raspberry Pi itself (see github.com/OpenRA/OpenRA/wiki/

Set up OpenRA

1. Clone the game engine

Open Terminal on your Pi, and enter `git clone https://github.com/Mailaender/OpenRA`. The game engine starts to download. Once the download is complete, switch to the directory with `cd OpenRA`, then install the necessary software to compile it by running `sudo apt-get install nuget mono-complete liblua5.1-0 libsdl2-2.0-0`. Next, press 'Y' to proceed.

2. Modify the config files

Once the software dependencies have been installed, run `nano configure` from Terminal. On line six, change `usr/lib/i386-linux-gnu` to `/usr/lib/arm-linux-gnueabi`. Press 'Ctrl-X', 'Y', then Enter, to save and exit. Next, enter the command `nano Makefile`. Scroll down to line 36, and change `dmcs` to `mcs`. Save and exit in the same way.

3. Compile OpenRA and download files

From Terminal, run `./configure`. Next, run `sudo make dependencies`. To compile OpenRA itself, run `sudo make all`. Once the game has compiled, you can run it at any time by switching to the OpenRA directory, and entering `./launch-game.sh`. Choose your game, then download the necessary game files.

OpenRA-on-RaspberryPi). Although this doesn't seem to be true in practice, the developers do warn that you may see the heat indicator at the top-right of your Pi's screen. Although this didn't happen during our (brief) tests, if you see the indicator, you must switch off your Pi immediately to avoid permanent damage. This warning doesn't affect using the Pi as a dedicated OpenRA server.

OpenRA doesn't claim to be an exact recreation of the original games, so you may find that play doesn't quite reflect what you remember when looking back through rose-tinted spectacles.

Specifically, OpenRA has introduced certain special visual effects, such as leaving trails behind aircraft, as well as altering the interface. Modders will also be pleased to hear that the engine has dispensed with one almighty INI file in favour of a series of modular YAML files. This allows for much finer control.

If your hunger for real-time strategy games has been whetted, and you want to see what OpenRA comes up with next, either visit www.openra.net, or join the conversation at irc://chat.freenode.net/openra. ■

Ten next-level Android hacks

No ROM flashing, no root access required — Darren Yates reveals our 10 favourite hacks to take your Android device to the next level.

We keep saying it because it's true — Android smartphones are the ultimate personal computers. Multi-core chips, wireless capabilities and a pretty decent operating system allows these devices to do much more than make phone calls and play games. To prove it, this month we've rounded up our 10 best next-level hacks showcasing just how good phone hardware is — and best of all, there's no ROM flashing or root-access required.

TURN IT INTO A LINUX DESKTOP

Android is built on Linux, as is Debian. So why not get some desktop Debian Linux on your Android device? Thanks to a couple of excellent free apps on Google Play — GNURoot Debian and XServer XSDL — you can download and install your own fresh copy of Debian Linux onto your Android device as if it were just another app. Granted, it'll chew up a decent amount of storage (I'd have at least 3GB free if I were you), but it'll give you a genuine desktop experience and depending on your device's SoC CPU, you should get more than passable performance. What you won't get is 3D graphics support, so don't expect to fire up Steam, but for desktop-grade office applications like word processing and spreadsheets, we've found it to work surprisingly well. Provided your device supports Bluetooth, you can even quickly add in a keyboard and use it as a desktop on-the-go. We covered the full setup process back in APC 449 (page 98) and while it's ideal for tablets, it'll even work on phones if you have good eyes. Oh, and despite the 'GNURoot Debian' name, your Android device doesn't need root-access for this to work.

WATCH TV DATA-FREE

If you have access to all-you-can-eat Wi-Fi, watching free-to-air TV on your Android device is a no-brainer, thanks to Freeview FV and the free-to-air TV networks. However, if you're on anything else or anywhere else,

it'll cost you data. But there is an ultimately cheaper option — and that's to plug in a USB DVB-T dongle. You'll need an Android device with working USB-OTG port, a USB-OTG adapter cable, low-cost USB DVB-T dongle with Realtek's RTL2832U chip and the 'Aerial TV' app from Google Play. Most tablets have USB-OTG available, so too, most mid-range or better phones. The USB-OTG adapter cable will cost you a dollar or two on eBay and an RTL2832U-based USB TV dongle should be around the \$10 mark. Since the TV dongle is picking up free-to-air TV signals, there's no extra data involved, so you can run your device in airplane mode and it'll still work. As your phone has to now also power the DVB-T dongle, battery life will take a hit, but you should still get several hours of viewing.

READ YOUR CAR'S ENGINE

Almost all cars sold in Australia since 2002 include an On-Board Diagnostics II (OBD-II) interface, a port that allows connection into your car's computer or engine control unit (ECU). With that connection, you can read all sorts of vehicle data from speed to engine revolutions per minute (RPM) and bucketloads more. What makes this even more useful is the myriad of low-cost plug-in receivers available that

Add an RTL2832U DVB-T dongle and the Aerial-TV app to watch TV data-free.

43%

Scanning 599.50 MHz (DVBT)

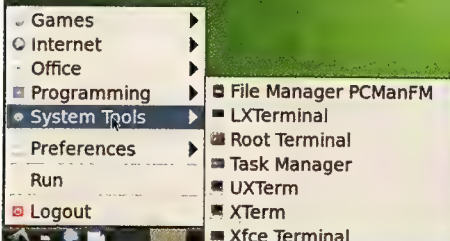
1	ONE	DVBT @ 219.50
2	ABC	DVBT @ 226.50
3	SBS ONE	DVBT @ 184.50
7	7 Sydney	DVBT @ 177.50
9	Channel 9 Sydney	DVBT @ 191.50
10	TEN Digital	DVBT @ 219.50

CANCEL



Your phone will need USB-OTG support, plus a USB-OTG adapter cable.

Turn your Android device into a Linux desktop with free Google Play apps.

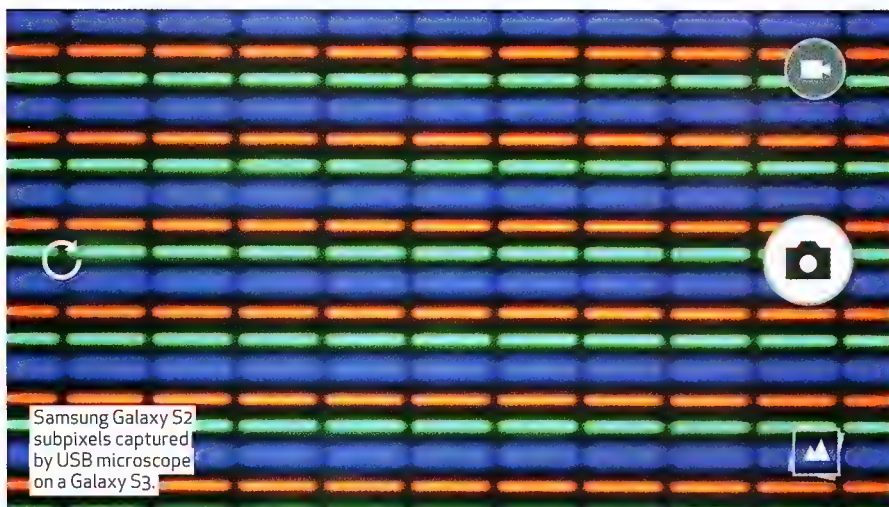




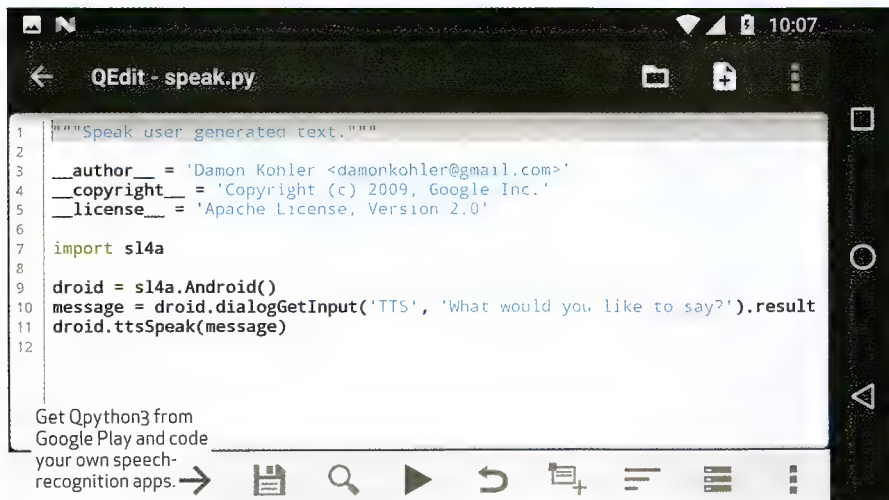
Tap into your car's computer with a Bluetooth-enabled OBD-II dongle.

provide a Bluetooth connection to the ECU. They sell on eBay for as little as \$5 and in Australia for usually much more, but combined with one of the many free Android apps available, you can tap into ECU data and learn more about what your vehicle is doing. Many of the sub-\$20 devices available are based on hacked firmware from an ELM327 chip create by Canadian

manufacturer ELM Electronics. There are no guarantees these knock-offs won't do damage to your vehicle, so research before you buy. Still, we bought two cheap units from eBay, had success with both and no adverse reactions. Torque is our app of choice — it's available on Google Play. The free version is great, the paid-for version even better.



Samsung Galaxy S2 subpixels captured by USB microscope on a Galaxy S3.

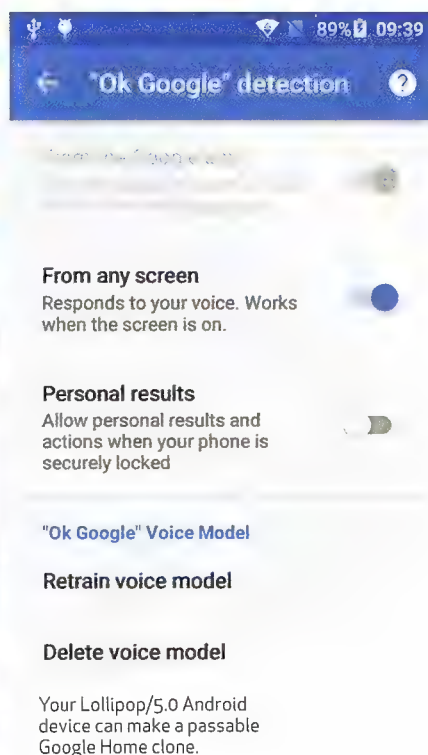


CODE YOUR OWN SPEECH-RECOGNITION APPS

Smart speakers, like Google Home, are taking the world by storm with their speech-recognition capabilities, but swapping hats for a moment, there's another way you can tap into speech-recognition tech — and that's by learning to create your own apps. Python is one of the world's favourite programming languages and also one of the easiest languages to learn. Now, yes, Android apps are usually coded in Java, but with the free Qpython3 app from Google Play, you can code some impressive Android apps with Python instead. For example, you can tap into your device's Bluetooth and speech-recognition functionality. The trick is using the Scripting Language for Android (SL4A) plugin built into Qpython3 — we covered this recently in our Learn to Code Python masterclass series (see issue 446). Combine Bluetooth with speech recognition and you can use your phone to turn on gadgets using your voice, or you can forget the Bluetooth and just code voice games like 'guess that number' using binary search. Coding is fast becoming a prerequisite in many jobs, so you could just combine Qpython3 with one of the many Python e-texts on Google Play and learn to code on your way home from work.

MAKE YOUR OWN GOOGLE HOME CLONE

Speaking of smart speakers, devices like Google Home and Amazon Alexa might well be all the rage at the moment, but why spend money on



Turn your Android device into a monitor with a USB video capture dongle.



Plug a USB microscope into your phone and see the world in miniature.

"Android devices are great for streaming video or playing video files, but with a little work, you can turn yours into an analog video monitor."

one when you could (almost) make your own out of your left-over tech? You just need an old phone or tablet with at least Android 4.4/KitKat and the latest version of the Google app. We tried it on an old Boost/ZTE B816 phone I bought for \$19 from Coles a while ago, allowed the latest updates and it worked. However, the KitKat/4.4 OS requires you keep the Google app front-and-centre otherwise, the "OK Google"

voice detection stops. By contrast, Lollipop/5.1 gives you the option to have voice detection on any app screen. For example, say "OK Google, play some music," and KitKat launches Google Play, playing any suitable music file located on your device. Lollipop does likewise, but it also lets you interrupt the music to ask something else, such as what day it is, whereas KitKat doesn't. On some occasions, Google

A Burr-Brown PCM2704 DAC may improve audio output on USB-OTG phones.



Search will show rather than say search results, so it's not an exact replica of the Google Home experience. Still, depending on your needs, it might be enough. Try it – it's not as if it'll cost you much to find out (apart from some bandwidth).

TURN IT INTO AN ANALOG VIDEO MONITOR

Android devices are great for streaming video or playing video files, but with a little work, you can turn yours into an analog video monitor. We're giving the USB-OTG port a real work-out this month and here again, if your device has one of these ports, you should be able to connect up one of the many 'EasyCAP' USB analog video capture dongles that sell on eBay this side of \$10. You just need to make sure it has one of the supported video chips – UTV007, HTV600, HTV800 or STK1160 are known to work (these are the most common chips on the market anyway). Yep, it's analog video, but we've read of some hobbyist pilots using this technique to view through-the-lens video from their drones. You'll need one of these USB dongles, plus a USB-OTG cable and the EasyCap Viewer app from Google Play – from our experience, we suggest you plug in the USB dongle before you launch the EasyCap Viewer app, otherwise, the app may crash. The latest version of the app now supports video recording, but we recommend you have at least a quad-core CPU SoC chip on your Android device to limit the risk of dropped frames. Like all USB-OTG hacks, your Android device now has to also power the USB dongle, so battery life will be affected somewhat. Still, if you need a compact monitor and the budget is tight, this is one way to repurpose your old Android tech.

Capture Hi-Fi audio from Behringer's Xenyx 302USB mixer on your phone.



Make music with your Android device using USB or Bluetooth MIDI.

HOOK UP A USB MICROSCOPE

Microscopes were once the exclusive domain of commercial laboratories or school science departments, but thanks to low-cost optics and image sensor technology, that's no longer the case. If your Android device has a USB-OTG port, you can pick up a low-cost USB microscope, try out one of the many free microscope camera apps from eBay and display all sorts of objects in all their magnified glory on your device's screen. Sure, a \$20 USB microscope from eBay isn't going to have the optics to compete with a professional unit, but there's still a truckload you can learn from having one of these devices, even if it's as simple as magnifying the pixels on your smartphone or tablet screen and learning how they work. Given the price, the quality actually isn't too bad, even if you're only typically getting a 640 x 480-pixel video view. Most USB scopes also include six to eight white LEDs surrounding the lens with a variable control built into the USB cable to light up your object-under-view. Science, technology, engineering and mathematics are must-have skills and if you want to introduce your kids to science in a fun, low-cost way, you could do a lot worse than a USB microscope.

BUILD A CD-QUALITY DIGITAL AUDIO RECORDER

Audio recording on most Android phones is pretty hit-and-miss. Most offer the on-board microphone or a single input via the TRRS (tip-ring-ring-sleeve) headphone socket at best. But if your phone has a USB-OTG port, you can bypass the on-board audio tech and turn it into a genuine high-quality stereo audio recorder. The key is grabbing USB Audio Recorder Pro from Google Play.

The app comes with its own USB device drivers, allowing it to hook into many of the external USB audio sound modules available, such as Behringer's Xenyx 302USB — there's a well-populated device support list available at the app maker's website (tinyurl.com/ycmzaau9). What's excellent about this hack is that the audio quality recorded now has almost nothing to do with your phone — it's simply recording the PCM audio stream coming down the USB cable. It's the USB audio module doing the hard work of accurately capturing sound in digital form that determines the quality — and you're not necessarily limited to 44.1kHz/16-bit sampling and stereo channels either. If your device can sample 192kHz/24-bit and it's supported by USB Audio Recorder Pro, that's what the app will record. This is the best digital audio recording app we've come across on Google Play — it'll cost you about \$10, but we reckon it's worth every penny.

GET OLD-SCHOOL HI-FI AUDIO

When I was a kid growing up, listening to music was an event — you carefully slid out vinyl discs from their protective sleeves, desperately trying to avoid putting finger marks on the tiny grooves, or you pulled out a fancier plastic 5-inch disc from its case and slid it into a CD player. You then sat back and enjoyed larger-than-life sound coming from your (or your parents') Hi-Fi system. Yep, it's 'old-school', but kicking back for an hour or so of 'classics' is still an excellent recipe for de-stressing. Google first introduced USB audio support for Android in Lollipop/5.0, so you can avoid your high-priced headphones, plug your phone into a high-fidelity

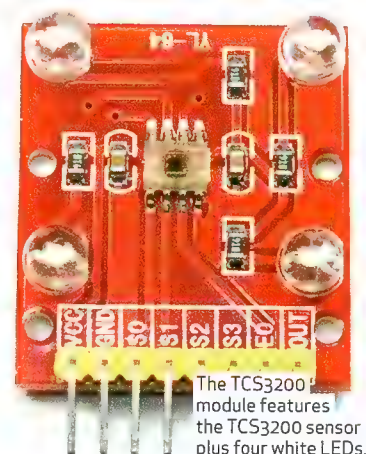
audio system via a quality USB digital-to-analog converter (DAC) and listen to rips of your parents' CDs you've stored on your phone. Shielded audio DACs using excellent Burr-Brown PCM2704 DAC chips with S/PDIF and analog audio output sell for as little as \$15 on eBay. Sure, phone audio is improving, particularly with chip-maker Qualcomm's new Aqstic audio hardware on the latest Snapdragon SoC CPUs, but for older phones with at least Lollipop/5.0, external audio DACs are well worth a look.

MAKE MUSIC

Yep, Android is pretty good at playing music, but these days, it can also be pretty good at making music. Grab a USB-MIDI (musical instrument digital interface) device, plug it into a USB-OTG adapter and into your phone. Next, follow it up with a good MIDI sequencing app like n-Track Studio 8 Music DAW from Google Play. Now your phone can actually make music via a musical keyboard. If your device has Marshmallow/6.0, you may be able to tap into 'Wireless MIDI', or MIDI over Bluetooth Low Energy (BLE). There are reports Yamaha's MD-BT01 Bluetooth MIDI device works on Android, but it's not yet officially supported by Yamaha. The other caveat is that MIDI is an optional extra in most Android devices, so we can't guarantee MIDI will work on all devices, but the n-Track Studio 8 Music DAW app is free, so it won't cost you anything to find out if you already have a USB-MIDI device. Still, if you're a musician and you have access to USB-OTG and USB-MIDI devices, you could well be able to carry a digital audio workstation and sequencer around in your pocket. Now that's pretty cool. ■

Make your Arduino see colour

Detecting light electronically is easy, but detecting colour? Darren Yates shows how to make your Arduino see millions of 'em.



The TCS3200 module features the TCS3200 sensor plus four white LEDs.

Some of the most interesting Arduino projects I've seen are M&M sorters, gadgets that will automatically sort your M&Ms – or any other coloured lollies – by colour into separate containers. The mechanisms used to do the actual sorting are usually quite elaborate, either using 3D-printed swivel arms attached to a high-grade stepper motor or mechanical arms that pick up individual lollies and move them around. But no matter which sorting method they use, they all need to have at least one feature in common – and that's being able to determine colour.

COLOUR-TO-FREQUENCY

You could try using a video camera for this – and it would probably work. But there is a simpler, more affordable technique called 'light-to-frequency conversion' inside a device called a 'programmable colour light-to-frequency converter'. We'll just call it a 'colour detection sensor'. One popular sensor that plays nicely with Arduino is the TCS3200 from Texas Advanced Optoelectronic Solutions (tinyurl.com/y8e7l1ck, PDF). It sells on eBay for about \$5 as a complete ready-to-use module.

The TCS3200 sensor is made up of an 8x8 array of photodiodes, 64 in total, interleaved and matrixed four ways – 16 with blue filters, 16 with green, 16 red and 16 with no filter. You programmatically select a particular

colour filter and the sensor first converts light intensity hitting those photodiodes into an electrical current. That current is then fed into a circuit called a 'current to frequency converter'. This creates a squarewave electrical signal, whose frequency is proportional to the input electrical current and, hence, the initial light intensity – the greater the amount of light detected, the higher the frequency. Combining results from each of the colour filters in turn means we can detect colours – potentially 16.7 million of them.

The module inputs S2 and S3 select the particular colour filter (red, green, blue or clear) while inputs S0 and S1 set the frequency scaling (setting these inputs to 'low' puts the TCS3200 into a 'power down' mode to greatly reduce power consumption).

HOOKING UP TO AN ARDUINO NANO

There are two different module form-factors available – one that has pin connections on two edges and one that has them only on one. We've chosen the single-edged version. What makes the TCS3200 in general easy to use from a layout viewpoint is that it doesn't rely on I2C, the 'inter-integrated circuit' bus. I2C is only available on pins A4 and A5 on an Arduino Uno or Nano and by not having to use I2C, we have somewhat greater

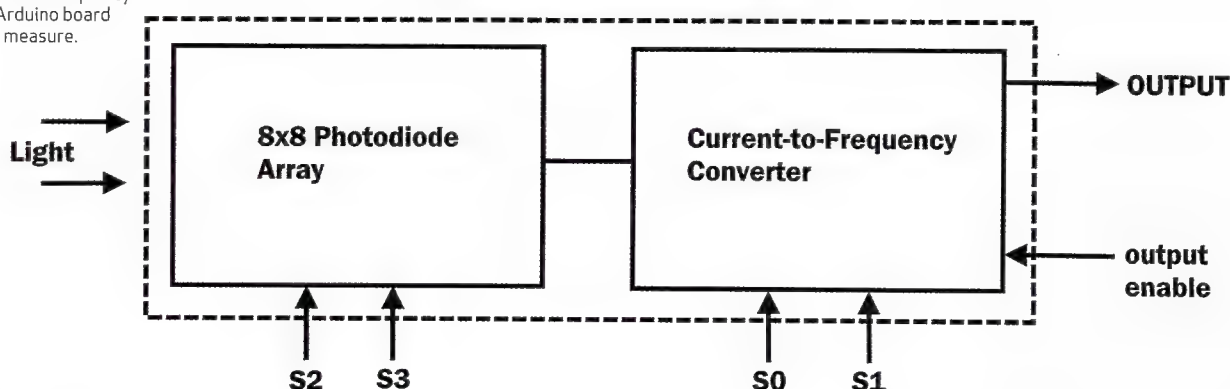
versatility in how the module does connect. It also allows us to use our favourite combination of Arduino Nano and the tiny 170-tiepoint breadboard. By following the overlay diagram, you can essentially just slot the TCS3200 module into the breadboard – nice and easy. However, we are still tied to using the Arduino pin D5 – it must connect to the TCS3200's OUT pin. Elsewhere, by plugging in the module into the Nano's end-eight digital I/O pins, the only two wire links we need are one to Vin and one to GND to provide power (this doesn't cause problems to the Arduino Nano's D11 and D12 pins).

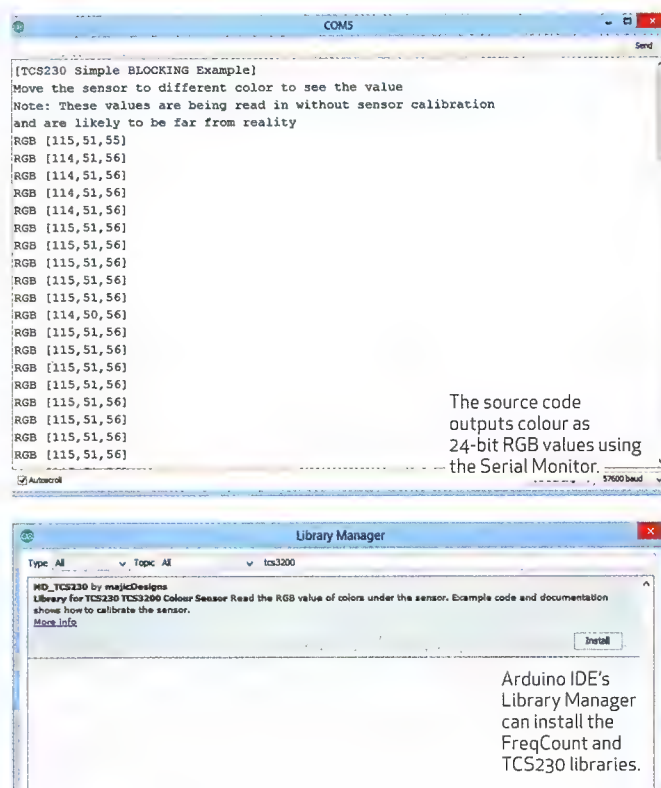
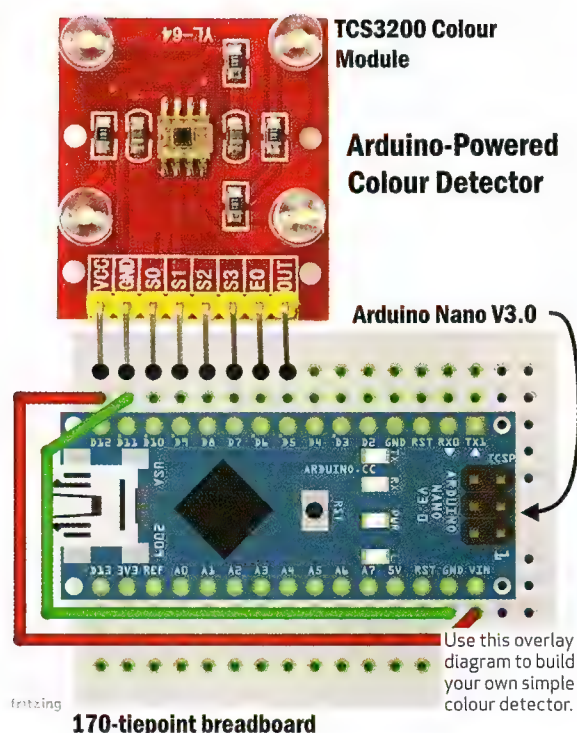
SOURCE CODE

You can find source code for this month's mini-project on our website at www.apcmag.com/magstuff. There are two libraries you'll need and they can be both installed through the Arduino IDE itself – the libraries you need are 'MD_TCS230' and 'FreqCount'. Launch the IDE and from the menu, select Sketch, Include Library and choose 'Library Manager'. Search for the two libraries, click on them and install them. The source code first selects the TCS3200's red colour filters and measures the frequency of the signal coming in on the Nano's pin D5. That frequency is mapped to an 8-bit value and stored. Next, it selects the green colour filter, measures the frequency, maps it to 8-bits and stores it,

The TCS3200 converts light into frequency an Arduino board can measure.

TCS3200 Functional Diagram





then likewise for blue, giving distinct 8-bit values for each colour filter, red, green and blue. Together, these make up a 24-bit RGB value, for a resolution of up to 16.7million colours. Think of it as a slow one-pixel camera.

The 'MD_TCS230' library enables us to interact with the sensor, while the 'FreqCount' library measures the frequency coming in on the D5 pin.

LEDS AND CALIBRATION

To aid in detecting colours more uniformly, most modules will include four high-brightness white LEDs. Unfortunately, these LEDs on the single-edged module turn on immediately you plug in power – there's no way to control them. Not easily, anyway. However, they do provide a consistent light source to light your object with.

The other issue is calibration – the MD_TCS230 library comes with basic calibration code to set this up. However, for most sorting-type projects, it's not really necessary. Why? Say you're sorting M&Ms. Place a red M&M over the sensor and even with the four white LEDs, the RGB values you'll get will vary over a small range – they won't be exact. That means, in order to detect 'red', you'll need to cover a small range of 8-bit values, which maybe '220-235' for red, '0-20' for green and '0-20' for blue. If you're making commercial devices, yes, calibration would be important, but for one-off home projects, you just need to test the object whose colour you want to detect, capture the readings from

the TCS3200 module and use those as a reference for that particular module and colour. The good thing, though, is you only have to do that once for each object.

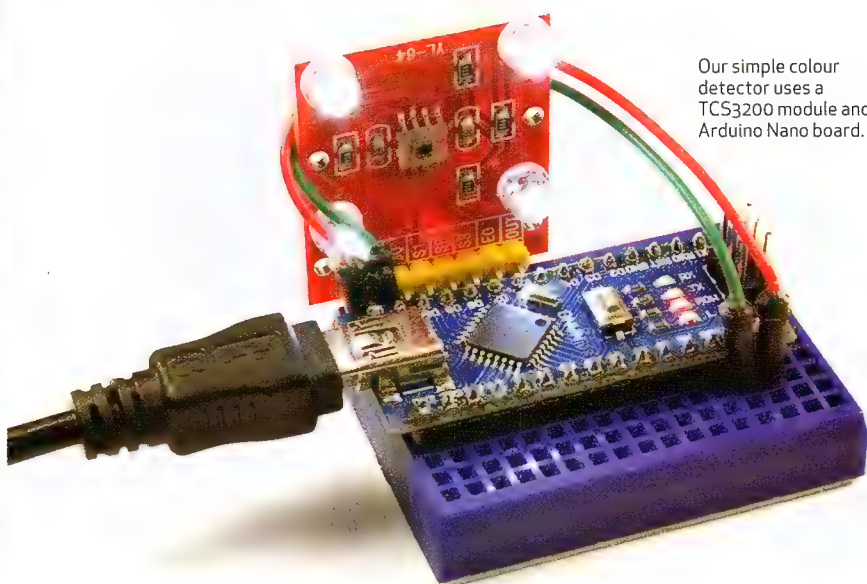
BUILDING OUR TEST PROJECT

We've made our colour detector project as simple as possible – an Arduino Nano, 170-tiepoint breadboard, TCS3200 colour module and two short breadboard wires. Follow the overlay diagram and you should be fine. We've modified one of the example apps supplied in the 'MD_TCS230' library to work with our setup and called it 'colourpicker.ino'. This source code produces a running list of RGB

values on the IDE Serial Monitor (search icon, top-right of the IDE). Place an object of obvious colour near the sensor and you'll see the RGB values change, although even if you hold it still, those values will vary over a small range as we mentioned before — all detection sensors have a small amount of variation, which you must account for in any project you build.

SEEING IS BELIEVING

Colour sensor modules are usually the first key step to building any kind of sorting device and for simple sort jobs, they are a cheap and easy-to-use way to ensure your Arduino is no longer colour-blind. ■



Python's Boolean logic

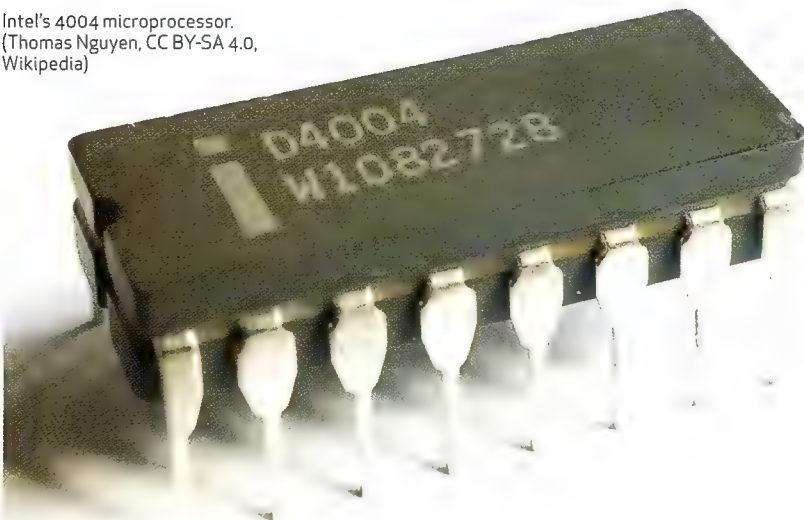
It's named after a mathematician from the 1850s and is a vital part of computer science today. Darren Yates explains how the logic of true and false works in Python.

Humans began building all-electronic computers during WWII, with Colossus helping decode Hitler's secret messages. Throughout the 1950s, computers grew in number slowly but steadily and with the launch of IBM's System/360 in 1964, they were fast becoming an important part of businesses around the world. But how was that all possible if Intel didn't invent the first microprocessor, the 4004, until 1971?

Prior to the 4004, computer processors were assembled from discrete components, first using individual transistors during the 1950s, then integrated circuits (ICs) in the 1960s. Those ICs miniaturised the original transistor circuit elements or 'building blocks' to allow more complex functions. The Intel 4004 took the next step by miniaturising those circuit blocks further until a CPU could fit into a single chip.

While these developments were all state-of-the-art at the time, the understanding behind them originated 100 years earlier with English mathematician George Boole. He developed a system of mathematics later called 'Boolean algebra' that not only underpins every computer architecture design today, but is vital to all programming languages, including Python. If maths isn't your thing, don't panic – basic Boolean logic is incredibly useful and quite easy to learn because it's, well, logical.

Intel's 4004 microprocessor.
(Thomas Nguyen, CC BY-SA 4.0, Wikipedia)



```

andop.py - C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/andop.py (3.6.1)
File Edit Format Run Options Window Help
# -----Alter these True, False values
a, b = True, False
# -----Alter these True, False values

if a == True and b == True:
    print('both inputs are true')
else:
    print('at least one input is false')

Python 3.6.1 Shell
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>>
==== RESTART: C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/andop.py ====
at least one input is false
>>>
  
```

BOOLEAN WHAT?

Boole's system of logic is based around two possible end-values: 'true' and 'false'. He didn't realise it at the time, but this system of binary logic would develop into the field of 'digital electronics', from which computers would spawn. His system worked because the 'true' or 'false' values aligned with the two electrical levels a transistor could produce – 'on' or 'off'. But Boolean logic is also built right into the Python programming language and we can use it in if-conditional statements, thanks to three keywords or 'operators' – AND, OR and NOT.

To make the most of this masterclass, download Python from www.python.org and get this month's source code pack from www.apcmag.com/magstuff.

NOT OPERATOR

If you take a black-and-white view of things, if something is not true, it has to be false, just as if something is not false, it has to be true. This is the tenet behind the simplest Boolean operator – NOT. A more systematic way to describe it is with a diagram called a 'truth table'. For the NOT operator, there are two columns – 'input' and 'output'. There are also only two possible values – 'true' and 'false'. The NOT operator simply inverts whatever the input is – false becomes true and true becomes false.

The NOT operator is also a keyword in Python, so we can use it in code. An obvious place to use it is when constructing if-statements, like this:

```

weather = 'rainy'
if weather is not 'sunny':
    print('Take an umbrella
today!')
  
```

Remember, the action of an if-conditional statement only happens if the condition is true, so for the 'take an umbrella' warning to be printed, the value of variable 'weather' has to be not 'sunny'.

The Boolean NOT operator just reverses the input value.

Truth Table for NOT

INPUT 1	OUTPUT
FALSE	TRUE
TRUE	FALSE

AND OPERATOR

I have a coffee grinder in my kitchen – it plugs into a switched AC wall socket and also has a power switch on the front. The only way it grinds coffee is if both the AC wall socket switch and the grinder's power switch are on. Makes sense, right? This is an example of a two-input AND operation in action – if either or both of the two switches are off, nothing happens. It's only when the AC wall switch AND the grinder switch are both on that an electrical circuit is complete and the grinder runs.

Again, we can describe this AND operation in a truth table – it shows all the possible value combinations of two inputs, which can be either 'true' or 'false' and the only occasion when the output can be 'true' is when both inputs are 'true'. We've written this as a simple Python app called 'andop.py':

```
a, b = True, False
if a == True and b == True:
    print('both inputs are
true')
else:
    print('at least one input is
false')
```

Here, the if-condition is that both 'a' and 'b' are true – only then will the code print the message that both inputs are true. In any other combination, the message is that at least one input is false.

OR OPERATOR

You've got a mate over watching the cricket and you need pizza. If the outcome is whether or not you get pizza and the inputs are you and your mate ringing the pizza shop, again, there are four possible combinations – neither of you call, you call, your mate calls or you both call. As we saw with the AND operator, if neither of you make the call, you get no pizza. But here's where these operators differ – with the OR operator, if either of you call the pizza shop, you'll get pizza, plus if you both call, you'll also get pizza. On this occasion, the only time you don't get pizza is if neither of you makes that call. Again, you can see this play out in the truth table for a two-input OR function. You can also

```
*batavg.py - C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/batavg.py (3.6.1)*
# ---- Change this number ----
avg = 37.65
# ---- Change this number ----

if avg > 40 and avg <= 50:
    print('pretty good average')
elif avg > 50:
    print('pretty amazing average')
else:
    print('you need more runs!')
```

The opposite of 'less than' is not 'greater than'.

```
Python 3.6.1 Shell
File Edit Shell Debug Options Window Help
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>>
==== RESTART: C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/batavg.py ====
pretty good average
>>> |
```

```
guessthatnumber.py - C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/guessthatnumber.py (3.6.1)
File Edit Format Run Options Window Help
# Binary 'Guess that number' - Darren Yates, December 2017
import math
playAgain = 'y'

while playAgain != 'n':
    numQuestions = int(input('\nMax number of questions to ask (1-16): '))
    print('Think of a number between 0 and', int(math.pow(2, numQuestions))-1, \
        'and I will guess it in', numQuestions, 'questions.')
    input('Press enter when ready.')
    number = 0

    for thisQuestion in range(numQuestions, 0, -1):
        bitValue = int(math.pow(2, thisQuestion - 1))
        answer = input('Question '+str(numQuestions - thisQuestion + 1)+ \
            ': Is the number greater than or equal to '+ \
            str(number + bitValue)+' (y/n)?')

        if answer == 'y':
            number += bitValue

    print('I think your number was '+str(number)+'.')
    playAgain = input('Have another go? (y/n): ')

print('Thanks for play my binary number guessing game!')
```

Simple game uses binary maths and Boolean logic to guess a number.

```
Python 3.6.1 Shell
File Edit Shell Debug Options Window Help
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>>
RESTART: C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/guessthatnumber.py

Max number of questions to ask (1-16): 4
Think of a number between 0 and 15 and I will guess it in 4 questions.
Press enter when ready.
Question 1: Is the number greater than or equal to 8 (y/n)?y
Question 2: Is the number greater than or equal to 12 (y/n)?n
Question 3: Is the number greater than or equal to 10 (y/n)?n
Question 4: Is the number greater than or equal to 9 (y/n)?y
I think your number was 9.
Have another go? (y/n): y

Max number of questions to ask (1-16): 8
Think of a number between 0 and 255 and I will guess it in 8 questions.
Press enter when ready.
Question 1: Is the number greater than or equal to 128 (y/n)?y
Question 2: Is the number greater than or equal to 192 (y/n)?y
Question 3: Is the number greater than or equal to 224 (y/n)?n
Question 4: Is the number greater than or equal to 208 (y/n)?n
Question 5: Is the number greater than or equal to 200 (y/n)?n
Question 6: Is the number greater than or equal to 196 (y/n)?y
Question 7: Is the number greater than or equal to 198 (y/n)?y
Question 8: Is the number greater than or equal to 199 (y/n)?y
I think your number was 199.
Have another go? (y/n): n
Thanks for play my binary number guessing game!
>>> |
```

Convert 'yynnnnyy' to binary, you get '11000111', which is decimal 199.

Truth tables for OR and AND operators show the how Boolean logic works.

```

orop.py - C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/orop.py (3.6.1)
File Edit Format Run Options Window Help
# -----Alter these True, False values
a, b = True, False
# -----Alter these True, False values

if a == True or b == True:
    print('at least one input is true')
else:
    print('both inputs are false')

Python 3.6.1 Shell
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/orop.py =====
at least one input is true
>>>
  
```

see it in action in the source code app 'orop.py':

```

a, b = True, False
if a == True or b == True:
    print('at least one input is true')
else:
    print('both inputs are false')
  
```

Here, only one variable has to be 'true' for the if-condition to be true and print the appropriate message. However, both inputs must be 'false' for the 'inputs are false' message to be displayed.

COMBINING OPERATORS

So far, so good. However, it's when you start combining operators that things can get a bit tricky. For example, just as you're set to leave home for work, your car breaks down. You have two alternatives – you can take two buses or you can catch the train. We can turn

this into a combined AND-OR function – if the output is getting to work and the inputs are the mode of travel, we know that both buses must operate for you to reach your destination, so that's an AND expression, there. But alternatively, you can just catch the train, so there's an OR expression as well (it's great how language inherently tells us how this works). To code this, we could do (work.py):

```

train1, bus1, bus2 = True,
True, False
if train1 == True or (bus1 ==
True and bus2 == True):
    print("Yes, I can get to
work!")
else:
    print("Sorry, can't make it
today.")
  
```

Note the parentheses or 'brackets' around the 'bus1' and 'bus2' code in the if-condition. Brackets are often used not to just group operator functions

Truth Table for OR expression

INPUT 1	INPUT 2	OUTPUT
FALSE	FALSE	FALSE
FALSE	TRUE	TRUE
TRUE	FALSE	TRUE
TRUE	TRUE	TRUE

Truth Table for AND expression

INPUT 1	INPUT 2	OUTPUT
FALSE	FALSE	FALSE
FALSE	TRUE	FALSE
TRUE	FALSE	FALSE
TRUE	TRUE	TRUE

but to also help determine which operators are calculated first.

However, in this example, they're not needed. Remember 'BODMAS' from school – Brackets, Orders, Division, Multiplication, Addition, Subtraction? These are orders of precedence for mathematical operators. Boolean logic also has its own order of precedence and it is NOT, AND, then OR. In our example, the AND operation involving bus1 and bus2 happens first anyway because of that precedence, so the brackets are unnecessary. Where the brackets do come in handy is when you're combining NOT, AND and OR operators in larger expressions. For example (andnot.py):

```

a, b, c, d = True, False,
False, True
if not(a and b) or not(c and
d):
    print('one of these value is
false')
  
```

In this case, the expression 'not(a and b)' is true if either a or b – or both – are false, likewise with expression 'not(c and d)'. Combining the two expressions with an OR operator means that the if-condition is true if either a or b is not true or either of c or d is not true. However, we could also simplify this as:

```

if not(a and b and c and d):
    print('one of these value is
false')
  
```

Try it yourself in Python and play around with the True and False values (Boolean algebra is too complex to cover here, but if you're interested, there are various 'laws' to learn that govern simplifying complex Boolean expressions).




```
Python 3.6.1 Shell
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>> weather = 'rainy'
>>> if weather is not 'sunny':
    print('Take an umbrella today!')

Take an umbrella today!
>>>

You can use Boolean
operators AND, OR, NOT
in Python code.
```

```
workpy - C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/workpy (3.6.1)
# -----Alter these True, False values
train1, bus1, bus2 = False, True, True
# -----Alter these True, False values

if train1 == True or bus1 == True and bus2 == True:
    print('Yes, I can get to work.')
else:
    print("Can't make it today.")
```

```
Python 3.6.1 Shell
Python 3.6.1 (v3.6.1:69c0db5, Mar 21 2017, 17:54:52) [MSC v.1900 32 bit (Intel)]
on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:/Users/Darren/Python Code/Python_EP_20/NEW CODE/work.py =====
Yes, I can get to work.
>>>

Combining multiple Boolean
expressions in Python is easy.
```

COMPARISON OPERATORS

Another way we can obtain expressions that evaluate to either true or false is to use the comparison operators. Python supports all six:

```
> greater-than
< less-than
>= greater-than-or-equal-to
<= less-than-or-equal-to
== is-equal-to
!= is-not-equal-to
```

Note some of these carefully – the greater-than or less-than symbols come before the equals sign. Note, too, the 'is-equal-to' operator is two equal signs, not one.

UNDERSTANDING COMPARISON RANGES

A quick question – what is the opposite of 'less-than'? If you'd said 'greater-than', you'd be wrong. The correct answer is 'greater-than-or-equal-to'. Why? You have to think about numerical ranges. Take a look at the following code:

```
x = <<<put a number here>>>
if x < 15:
    print('x < 15')
if x > 15:
    print('x > 15')
```

If we made x equal to 5, x is less than 15 and would print so. If we make x equal to 24, x is clearly greater than 15 so, it would again print the appropriate message. But what happens if x equals 15? In this case, x is not less than 15, so the first if-condition is false and doesn't print. However, if you decided the opposite of less-than is greater-than, the expression 'x > 15' is also false, since the value of x is not greater than 15. In this case, the above code prints nothing because it doesn't handle when x equals 15.

If we wanted to check for a range of numbers, we can combine these comparative operatives with Python's Boolean operators. For example, in international cricket, a specialist batsman is doing well if their batting average is between 40 and 50. Anything over 50 is usually 'genius' level, but drop much below 40 and your place in the team could be at risk. We could code this as (batavg.py):

```
avg = 47.65
if avg > 40 and avg <= 50:
    print('Pretty decent
average.')
elif avg > 50:
    print('Pretty amazing
average.')
else:
    print('You need more runs!')
```

Again, notice the language – we said 'between 40 and 50', not '40 or 50'. In coding, you can't use the OR operator to find a range of numbers. Think about it – for an average to be between 40 and 50, it has to be both greater than 40 and less than 50. It must satisfy both requirements. If we used the OR operator, as in 'if avg > 40 or avg <= 50', we're looking for the average to be greater than 40 – that bit is fine – but then, it can be less than 50. An average of 13 is less than 50 and since only one of those OR'd expressions needs to be true for the if-condition to evaluate to true, a value for 'avg' of 13 would incorrectly satisfy that if-condition and print the message 'pretty decent average'.

GUESS THAT NUMBER

There's a simple maths game you can play with kids to show the power of binary maths and Boolean logic. We've created a version of it in this month's source code pack called 'guessthatnumber.py'. First choose the maximum number of attempts you want the app to ask. Choose five, for example. Have someone then choose a number at random between 0 and 31, keep it hidden and watch the app try to find out the number. Sounds simple enough, but there are two rules – the app only has those five attempts to discover the number and you can only respond to the app with answers 'yes' or 'no'. It might sound impossible, but the app will find the number within the set limits every time – thanks to binary maths and Boolean logic. Let's assume the hidden number is 29.

The trick is to consider the number as a binary number and use what some call the 'binary search' or 'successive approximation' technique. The range 0 to 31 can be covered by five binary digits or 'bits', the most significant of those has the decimal value of 16. The app starts by asking 'is the number greater-than-or-equal-to 16?' If you answer 'yes', the app sets that bit as a '1', otherwise it's a '0'. Either way, the app has worked out the first bit. The second-most significant bit has a value of 8. The app adds that to value of the first bit, which, here, is 16 and now asks 'is the number greater-than-or-equal-to 24?' Again, you answer 'yes', this bit also becomes a '1' and the app moves onto the next bit, which has a value of four. It adds that to 24 to get 28, asks you again and so on until it ends up with the bit stream after five questions of '11101'. As a decimal number, you get 16 + 8 + 4 + 1, which is 29.

Instead of 0 to 31 in five attempts, you could take it up to 0 to 1023 in 10 attempts, or even 0 to 65,535 in 16 attempts. That's literally the power of two – and a bit of Boolean logic. ■

downtimegames

EDITED BY CARMEL SEALEY

Pew pew pew pew!
No *Star Wars* game has
ever looked or sounded
this good.

PC, PS4, XO | \$99.95 | WWW.EA.COM

Star Wars Battlefront II

A surprise to be sure, but an uneven one.

The reboot of *Star Wars Battlefront* back in 2015, introduced more grandiose battles than ever before. Two years later, *Battlefront II* works to quell the largely casual appeal of the first game, adding more maps, characters, and even a single-player campaign. But it's hampered by a progression system that chokes on its aspirations.

Compared to the first game, the environments here are more varied, textures are more richly detailed, and everything you do is complemented by an authentic soundtrack of blaster bolts, explosions, and a fleeting orchestral score. The ground combat remains diverse and satisfying, too, with four different classes all offering unique traits. Regardless of which class you choose, the game makes short work of players who

go in all guns blazing, accurately conveying the illusion of playing a small role in an epic battle.

You don't always want to blend into the background, though, and that's where Battle Points come in. This system replaces the random token mechanic from 2015, allowing you to acquire mid-match reward points to use on special troopers, vehicles and classic *Star Wars* heroes. Playing the objective and scoring hits is the best way to rack up your Points, but with varying costs for characters, spending them demands a tactical approach. This has its pros and cons, as while it makes for a more varied and intelligent system than before, it also alienates less skilled players.

In *BII*, you can embark on a single-player campaign following Iden Versio, an Imperial commander. Her tale takes place during the

period between *Return Of The Jedi* and *The Force Awakens*, making for a unique point of view. Her chapters are broken up with side-missions in which you take control of Luke, Han and Lando, which sadly wrestle the focus away from Iden. Because of this, it's tough to feel for most of the new characters in the 5-6-hour campaign.

Multiplayer, however, remains the core with Galactic Assault the game's primary offering. Here, 40 players engage in vast battles while also meeting a series of objectives. *Starfighter Assault* sees you take part in full-on space battles. The mechanics of flying have been enhanced, and now you'll find yourself weaving in and out of impressive set pieces to achieve your goals.

However, all of the online multiplayer elements are affected by a progression

system. You upgrade using ability-enhancing add-ons called Star Cards. You get them in loot crates, which you can buy with in-game credits. When the game launched, the option to purchase them with real money was included; causing a backlash from the gaming community, so it was removed.

This type of approach is nothing new, but here its sheer invasiveness leaves a sour taste in the mouth. It's a system that never emits any kind of charm. Here's hoping with the DLC and further tweaks, it lives up to its mass potential.

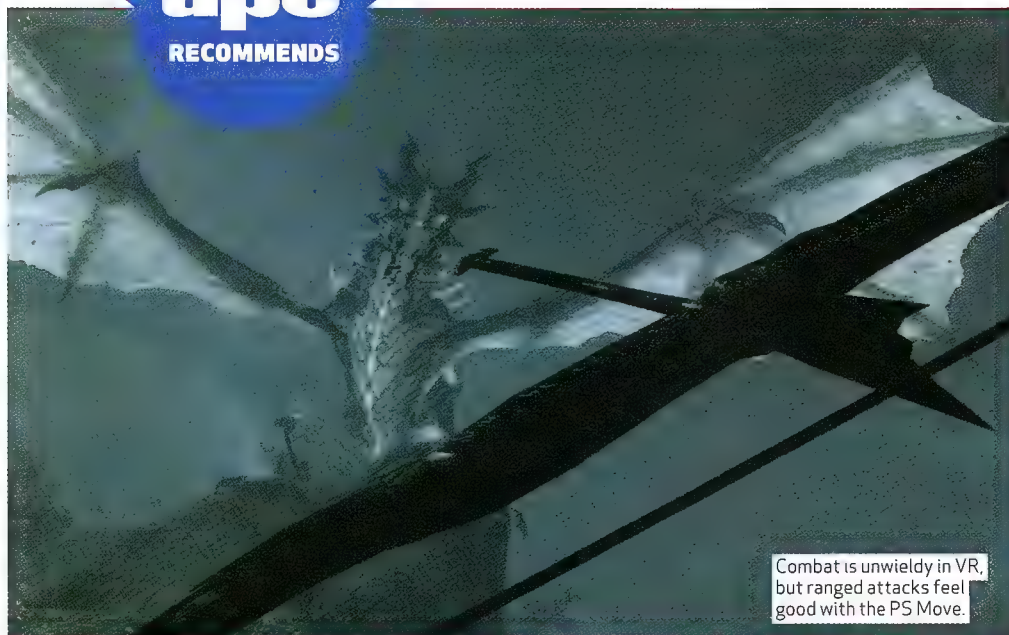
■ Fraser Gilbert

Verdict

Your *Star Wars* fantasy made real, wrapped around a poorly-designed progression system.



✓✓✓
apc
RECOMMENDS



Combat is unwieldy in VR, but ranged attacks feel good with the PS Move.

PSVR | \$99.95 | WWW.THEELDERSCROLLS.COM

The Elder Scrolls V: Skyrim (VR)

The classic RPG goes epically big via PlayStation VR.

How many times have you played through *Skyrim*'s introduction? For me, it's about a dozen times, each more frustrating than the last. It's not long, but when you're button mashing your way through an over-familiar sequence, it can feel like an eternity. At least, it can until you do it all again in VR. Then it's as breathtaking as your first ever playthrough. Perhaps moreso.

If you've played through this game once and feel like you had enough, this new PlayStation VR treatment isn't going to offer more than a passing novelty, one which will likely expire within an hour. But if you're coming to *Skyrim* afresh, or if you're eager for another 200-odd hour adventure, this VR port is a fantastic way to re-experience it.

Unlike Bethesda's *Doom VFR*, *Skyrim VR* is a straight port of the original game, though there are changes. By default, you're turning with the right stick by slight increments. This can be turned off in favour of full, smooth turns, but that's a one-way ticket to spew town. VR users will be



Challenge your arachnophobia in VR! Seems like a great idea.

familiar with this first-person incremental trick, but if you're new and unconvinced: just trust us, it works. Otherwise, the game's largely unchanged.

The graphics are stunning for a VR game, but due to the detail and draw distance, you'll occasionally notice some muddiness. But that's certainly not enough to detract from the experience of being in bloody *Skyrim*.

There are a few impediments. You'll probably not want to play this for long stretches at a time, for one. And that's OK — it holds true for any VR game — but it'd be very nice if it were possible to continue the adventure on

your TV screen, but since *Skyrim VR* is a separate title this isn't possible.

Fully-featured, 200+ hour VR games are still a rarity, and *Skyrim* doesn't feel disadvantaged in its move over. Whether you like *Skyrim* or not is something you've probably already established. But if you like the game and also like VR, this is a heady treat indeed.

■ Shaun Prescott

Verdict

An impressive VR transformation which sacrifices nothing.



Destiny 2: Curse of Osiris

The Curse of Osiris has proven to be a cure for playing *Destiny 2*.

PC, PS4, XO | \$29.95
WWW.DESTINYTHEGAME.COM/HOME

Getting the first batch of D2 DLC only a little over a month after initial release was great timing. A couple of weeks in and all but the most casual in the office were light-capped on at least one toon and even loading in to knock out Milestones on weekly reset felt laborious. Enter *Curse of the Osiris* and, hopefully, something to log in and grind for. Guardian level-cap has been upped to 25 with a light level raise as well. There's a new zone — Mercury — where the Vex are doing... something... in the future. It's typically bewildering but it's vital we stop it. There are eight new story missions in total which probably took a little over two hours to zip through. There's one new Public Event and Lost Sector on Mercury, plus three new Strikes, PvP maps and a new Raid lair. It sounds like a lot but, in reality, it feels empty and lifeless before you really get going. Ultimately, *Curse*, and *Destiny* as a whole, has left me wanting for a decent loot-shooter, so I've since gone back to revisit *Borderlands* and *The Division*, the latter being actually very, very good after a bunch of polishes, balance passes and content updates.

■ Troy Coleman





Doom VFR

The fast-paced FPS makes an awkward transition to VR.

VIVE, PSVR | \$39.95
WWW.DOOM.COM

When Bethesda announced *Doom VFR* at E3 last year, it seemed a bit optimistic that a foot-to-the-floor, high-speed FPS could make a smooth transition to VR. But it's better than expected, for two reasons: one, the game is a condensed, bespoke *Doom* game, not just a direct port of the 2015 title; and secondly, there's no free locomotion. In other words, you're warping around the map using your PS Move controllers (or the HTC Vive equivalent on PC). This works surprisingly well: moving around the map is fun and achieving glory kills is a matter of warping directly into ailing predators. Some will object to this dramatic departure from the FPS formula, but it's the only way to avoid the motion sickness a game as fast as *Doom* would impose on the player. As a VR game, it's a fun and violent shooter but hardly among the best. Try *Superhot VR* for a shooter that feels perfect for the platform.

■ Shaun Prescott



PC, PS4, XO | \$38 | WWW.DEFIANTDEV.COM

✓✓✓
apc
RECOMMENDS

Hand of Fate 2

Play your cards right.

This card-based caper provides all the nuances of an authentic real-world tabletop gaming experience, complete with decision making, dice rolling, and deck building. The ace up its sleeve is that, unlike its corporeal counterparts, you don't have to imagine the epic battles taking place, you actually play them out, in the style of an action game.

Your adventure is laid out with cards played from your customised deck. These range from battle-focused objectives, to shops where you can buy new weapons and supplies. Scenarios are varied and generally offer options as to how to proceed. Attempt an objective and you'll regularly be faced with challenges that ultimately rely on good fortune, such as reaching a certain number on the dice, or turning the correct card. Failure can be costly to your health and rations, making this an intricate game of carefully balancing your resources and boldly trying your luck. Roll a high enough number to aid a distressed damsel,



for example, and she'll reward you with food and coin. Fail and she'll double-cross you, calling her bandit friends to rob you — initiating a battle sequence.

Here, the tabletop setting is exchanged for a far more traditional experience that sees you go toe-to-toe with enemies directly. Picking the appropriate tactic for each opponent helps; use cutlasses to strike at swift and agile thieves, and best hardy northerners with a blend of carefully timed sword strikes and ripostes. Enemy blows inflict significant damage, and health doesn't regenerate automatically. This makes combat a challenging endeavour, one that's made more treacherous by very deliberate controls.

Battles feel weighty and significant, and brilliantly break up the text-based narrative — even if enemy types are reshuffled a little too often.

The game's demanding nature routinely makes you feel like you're trying to build a house of cards during a hurricane. This canny combination of gaming media provides a deep and satisfying virtual pen-and-paper RPG-esque adventure.

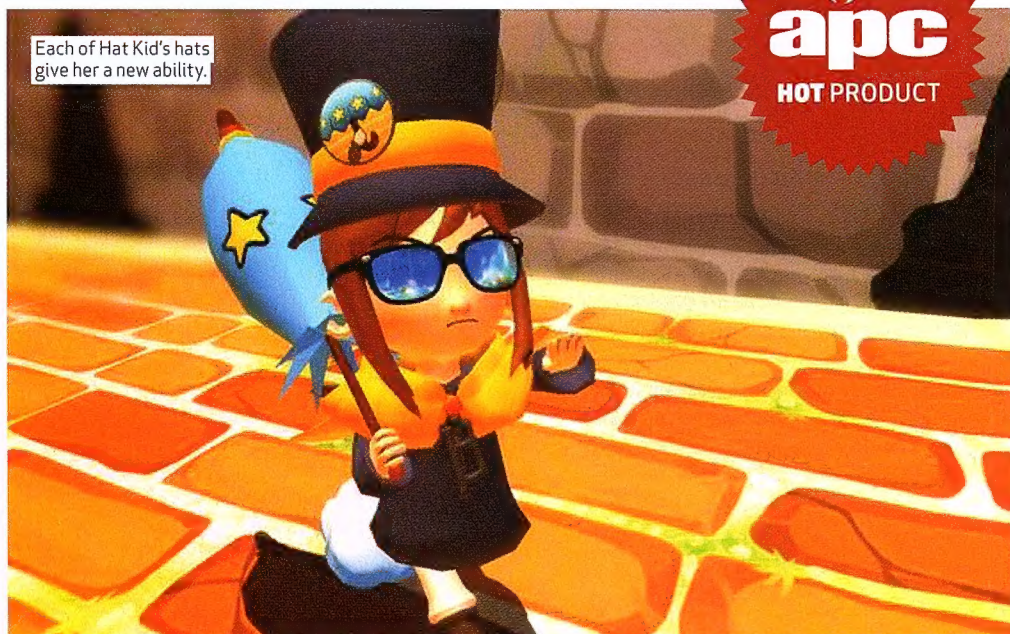
■ Anne-Marie Coyle

Verdict

An interesting mix between traditional tabletop RPG and action that really works.



Each of Hat Kid's hats give her a new ability.



apc
HOT PRODUCT

PC, PS4 AND X0 COMING SOON | US\$30 | HATINTIME.COM

A Hat in Time

From crowdfunding to crowd pleasing.

Spacefarer Hat Kid was on her way home, her cushy wood-paneled and pillow-filled spacecraft stocked with fuel. It was all going so well – until a burly Mafioso came floating through the void and tapped on the window to demand local taxes. One heated altercation later and all the fuel fell to the strange world below, along with Hat Kid herself, and only a lot of running, jumping and collecting of random shiny objects can save the day.

Fortunately, Hat Kid is more than capable of rising to the challenge. Her goal is to recover the 40 Time Pieces that power her ship, which are scattered across the surface of a strange, cartoony Earth. The game kicks off on Mafia Island, a tightly wound playground that serves as a tutorial. It's easy to navigate but complex and multilayered, boasting strange geometry to practice wall-jumping and belly-sliding on, but little in the way of threats.

It's a playful and creative place, indicative of the game as a whole. The 'Mafia' are burly goons in blue suits

drawn from a child's understanding of what a Mafia Guy is like. They're dumb, strong, speak with a vague accent, menace little old ladies, do Professional Crimes, and like to cook. The humour doesn't always make sense, but it's consistently weird and charming.

After completing certain chapters or collecting enough yarn, you'll unlock new hats, each bestowing a power such as the ability to turn hazy green outlines into briefly tangible footholds. There are a lot of abilities and platforming skills to learn, from a flexible wall-climbing scramble, to a traditional double-jump that can be extended in mid-air with a horizontal dive.

While the first Time Pieces are doled out quickly as you complete tutorial objectives, it opens up dramatically after you've collected a few. Each world has a different aesthetic, characters and scale. The fourth world, Apline Skyline, is a non-linear web of interconnected platforming challenges – all without a safety net and no easy goal in sight.

The middle two worlds are the most colourful and memorable. Hand-holding is reduced, trusting you to explore and puzzle your way to a solution. It feels like the game itself is gaining confidence in you.

A *Hat in Time* never loses focus on what it is. Even the level framed as a murder mystery plays out as evasion-focused stealth platforming bookended by weird comedy skits.

It does lack consistency in some ways, though. The first world establishes a conflict and a primary antagonist which is almost entirely forgotten right up until the grand finale, for instance. And the camera, while usually well-behaved, can get squirrely in tight corners. These are only minor gripes, though.

A *Hat in Time* is a rival to some of Nintendo and Double-Fine's greatest bits of design. **■ Dominic Tarason**

Verdict

The simple act of running, collecting, belly-sliding and double-jumping never gets old.



apc
HOT PRODUCT

Pokemon Ultra Sun & Ultra Moon

A suitable sunset for the series as the 3DS wanes.

NINTENDO 3DS | \$50
WWW.NINTENDO.COM.AU

The seventh generation of *Pokémon* games are the last to come out for the 3DS system as the series shifts to the Switch, and as such, *Ultra Sun* and *Ultra Moon* represent the final hurrah. For those that played *Sun* and *Moon*, much of the *Ultra* experience will be familiar to you as they aren't true sequels (in the vein of *Black* and *White 2*), but are instead a refined twist on the original. This fine-tuning is certainly welcome, from the small improvements such as a clarified UI and menu system to more significant additions like entirely new *Pokémon* and mini-games. A lot of the more meaningful changes will show up much later in the game, particularly those that relate to plot, and so it can be a bit of a chore progressing through the early game if you've finished *Sun* and *Moon* in recent months. For everyone else, these are the best *Pokémon* titles yet and the closest you'll get to 'playing' the anime series thanks to the rich characters and vibrant, living world of the Aola islands.

■ Harry Domanski



Recipe Chocolate chip and cardamom cookie

Google



GLUTEN FREE GOAT
BAKERY & CAFE

INGREDIENTS

Tapioca starch	1/2 cup + 2 TBSP
Brown Rice Flour	1/2 cup
Org. sugar	3/4 cup + 1.5 TBSP
Cardamom	2 tsp
Flaxseed meal	1.5 TBSP
Sorghum Flour	1/4 cup
Raw sugar	1/4 cup
Xanthan gum	1.5 tsp
Sea salt	1.5 tsp
baking soda	1 tsp
Chocolate chips	1 cup
water	3/4 cup
Safflower oil	3/4 cup

DIRECTIONS

Combine all the dry ingredients except the chocolate chips, in a bowl and mix well.

In another bowl, combine all the wet ingredients, and then add to the dry ingredients and mix enough to combine.

Add the chocolate chips and fold in until just mixed. Using a large spoon, drop on parchment lined sheet pan and bake at 350F for about 12 minutes.



AI creates fake porn

THE REAL DEAL WAS TOO VANILLA.

Artificial intelligence is a powerful technology — it may hold the cure for cancer as readily as it holds the cure for peak-hour traffic jams. It has also proven itself a master at playing Go, an apprentice chef and even a fairly creative place namer. However, in questionable hands, AI can also be responsible for fake celebrity porn. Current *Wonder Woman* actress Gal Gadot, as well as Arya Stark's Maisie Williams and Hermione Granger's Emma Watson have all found their faces plastered on porn stars' bodies using a face-swap algorithm. This particular software can, according to the creator, be used by anyone with a working knowledge of machine learning. Not only is that a scary prospect for anyone who has videos or pictures of themselves on the internet, it's also an unnerving taster for the fake news of the future.

KFC's Internet Escape Pod

THE PERFECT FAMILY GETAWAY?

Ever want to just get away from it all? Internet, messages, viral cat videos, emails, fake news, real news, user-created YouTube videos claiming to be trailers for upcoming movies that are just clips from previous films with stock epic soundtrack music for the score? Yes, yes, no, yes, yes, yes and yes! Well, thanks to KFC, you can now huddle under the safe arms of the Colonel himself. Behold, the KFC Internet Escape Pod — a glorified tent in which to eat, presumably, fried chicken out of a bucket. Yes, it's real and it costs US\$5,000 (tinyurl.com/apc451-kfctent). While the tent doesn't actually provide any tested internet-blocking tech, it does claim to provide you a "sanctuary from digital temptation under Colonel Sanders" and is like "a magical force field". Make of that what you will. In our books, it's just a very expensive joke. ■



Google's chocolate chip and cardamom cookies

Cooked and rated by your Chip Chat reporter!

Well, we said we'd do it, and since we had a break over the Christmas/New Year period, we thought there was no better time to attempt Google's AI-created recipe. First and foremost, we would like to say that the AI's ingredients list is a little on the fancypants side — including flaxseed meal, sorghum flour and xanthan gum (the last two of which we had to order online, no less) — but in the end, we managed to get it all. After combining, folding, kneading, squishing and then finally forming into cookies and baking for about 12 minutes, we would say the cookies were only 'all right'. Of course, this is subjective. We'd recommend experimenting with the cooking time to make sure they're either as soft or crunchy as you'd like them. And you don't have to buy organic sugar or sorghum flour if you have regular, but then it wouldn't be Google's AI's recipe anymore, would it?

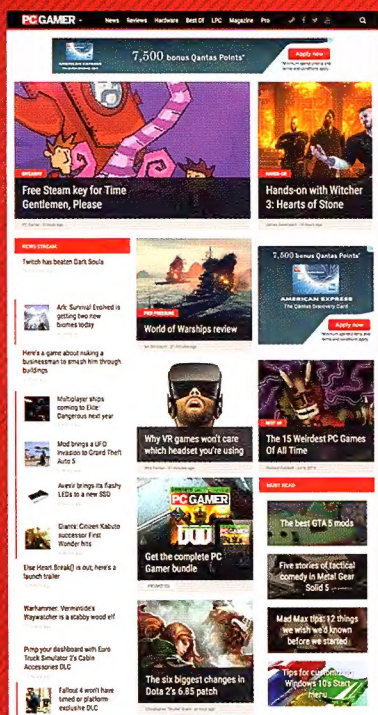


Domino's pizzas are getting checked by an AI

WILL IT BE A STING IN THE DRAGONTAIL?

Domino's is well known for its quality pizzas. No, sorry, I can't. Can I start again? Domino's is well known for its cheap pizzas, and the company has recently announced that it will soon be incorporating Dragontail System's pizza-checking AI-powered QT camera system. This "electronic eye" will apparently sit above the cutting stage of production and take photos of the pizzas as they pass, taking notes on its features and temperature. What will happen to these pictures? Well, the customer will apparently be able to track their incoming meal, which includes this picture, and will be informed whether it passed the quality test. We are unsure what happens if the pizza fails (as in, do you still get it, or will the system automatically cook you another one?), but let's be honest, we're also unsure whether we'd notice the difference between a pass and a fail!

SMARTER COOKIES ENABLED



JOIN US ONLINE AT
WWW.PCGAMER.COM



REPUBLIC OF
GAMERS

NO.1 GAMING MONITOR BRAND



ROG STRIX **CURVED** GAMING MONITORS MAXIMIZE YOUR GAME

ROG STRIX XG35VQ

UWQHD
3440x1600

100Hz
Rapid Refresh
Rate



Extreme Low
Motion Blur

ROG STRIX XG32VQ

WQHD
2560x1440

144Hz
Rapid Refresh
Rate

125%
sRGB

ASUS Australia & New Zealand



www.asus.com.au

ASUS